FROM CAVE PAINTING TO COMIC STRIP

To W.F.

A business man who is also a visionary

FROM CAVE PAINTING

TO COMIC STRIP

A KALEIDOSCOPE OF HUMAN COMMUNICATION

by LANCELOT HOGBEN

With 20 pages in full colour and 211 illustrations in black and white,
selected by Marie Neurath, Director of the Isotype Institute

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FOREWORD

Though my name appears on the title page as the author of this book, I cannot honestly claim to be the male parent. A suggestion of Marie Neurath was the act of fertilisation whereby I myself, and at first a little coyly, conceived the plan of a script for a picture gallery of her own choosing. Our intention was to publish it only in America, an intention fortified by my conviction that the first priority in our native setting of austerity and paper shortage should be for books to make us laugh again. Its publishers have talked us out of this resolve, but have not persuaded me to undertake the labour of translating it into my mother tongue. For my own part, I cannot with confidence recommend it as reading matter to my fellow countrymen. Fortunately this does not matter much to Marie Neurath. Her pictures tell their own story.

Lancelot Hogben

CONTENTS

Index and Acknowledgments
appear on pages 281-288

BEFORE 13000 B.C.	13000 B.C. TO 10000 B.C.	10000 B.C. TO 7000 B.C.	7000 B.C. TO 4000 B.C.	4000 B.C. TO 1000 B.C.	1000 B.C. TO 1950 A.D.

LIST OF ILLUSTRATIONS

ILLUSTRATIONS IN ONE AND TWO COLORS

The book contains over 200 illustrations in black-and-white photogravure,
including contemporary paintings, engravings and drawings,
photographs from a wide range of museum exhibits,
facsimile reproductions from early books, and a number of specially constructed diagrams.
The map-endpapers in two colors show the approximate extent of the civilisations
and the sites of places mentioned in the book.
Approximate periods covered by each chapter are compared in the List of Contents

FROM CAVE PAINTING TO COMIC STRIP 1

Sex, Seals and Signatures

This book is a panorama of the emergence of man as the only literate animal species and a preview to the liquidation of illiteracy on a world scale as a prelude to the unification of mankind. So our story starts with what Julian Huxley happily calls the uniqueness of man. Wherein lies this uniqueness? With wisdom way beyond much of what passes as modern thought, the most notable of the Founding Fathers defined man as a tool-making animal; and Franklin's aphorism does in fact epitomise in simple factual terms one, if only one, characteristic of the uniqueness of our species. Others are equally susceptible to plain statement. Man is the only talkative animal, and man as we know him to-day is the only picture-making animal.

A writer who starts a picture book with such an assertion invites more than a suspicion of salesmanship from a discriminating public told once too often that the author of the universe is a great mathematician. If it is worth stating, it is worth making clear; and to do so we should face up to one fact at the outset. Man is not very odd from the viewpoint of the anatomist. The supporters of Darwin were dead right about that, if all too obstinate in getting to grips with the indisputable oddity of man as a zoological exhibit. With the controversies of Darwin's contemporaries behind us we can now say so without luxuriating in the delusion that we have done our verbal duty by equipping human kind with a soul; and we need not shirk our scientific duty by failing to put man in his proper place in the brute creation.

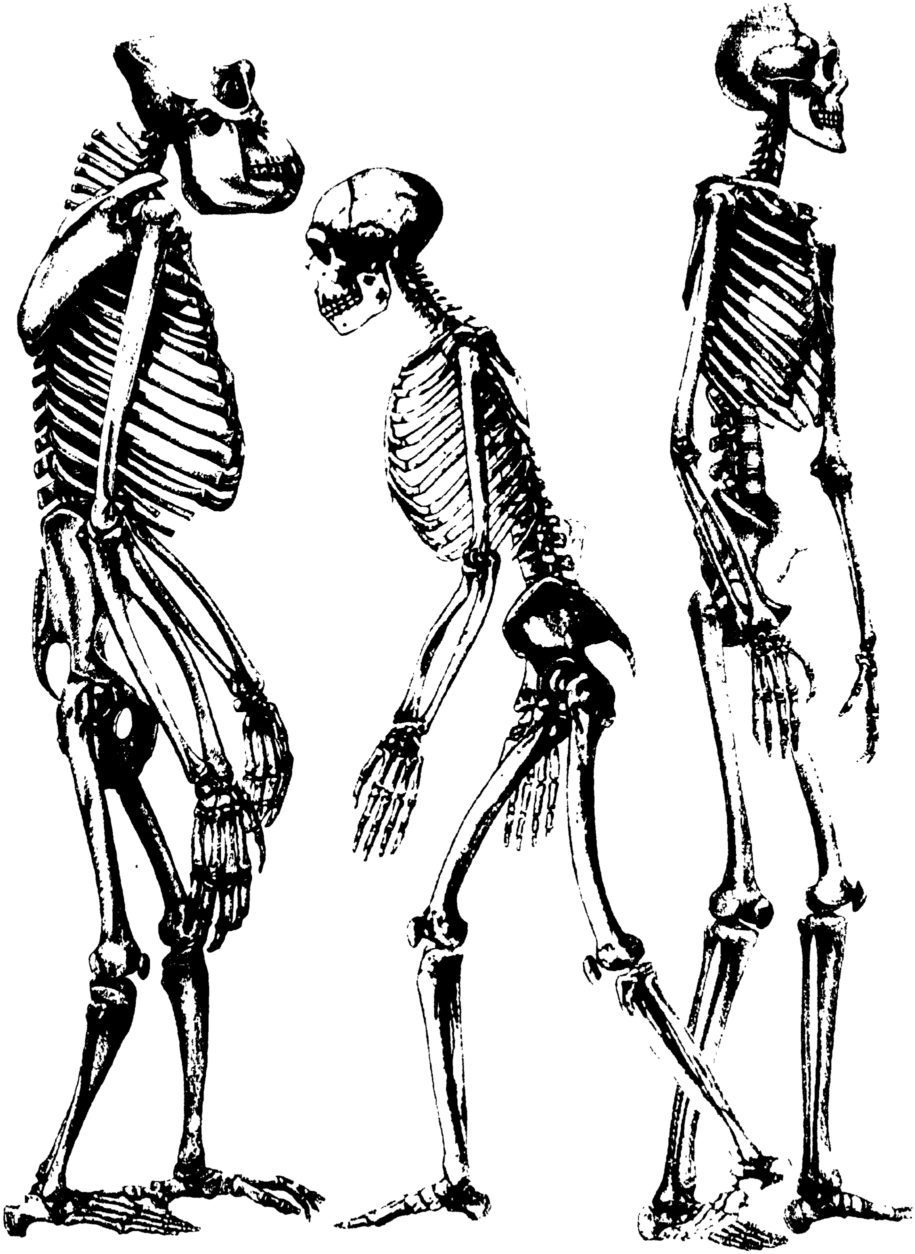
Let us therefore take stock of what man admittedly owes to a peculiar combination which he shares with his nearest relatives, monkeys and

1 *Man is not very odd anatomically. Two of his most useful physical characteristics, the ability to focus both eyes on near objects and to handle things easily, he shares with the other Primates, notably with the Tarsier, a link between the monkeys and the tree-shrews.*

apes. Man can focus both eyes on a near object, as a cat can, a circumstance which endows him with a sense of depth; and he can handle things as a squirrel can handle nuts or a chameleon can handle a twig. This coincidence has contributed no little to his success as the dominant animal species on our planet; but it does not suffice to define man's uniqueness. That he can do both is part of his monkey heritage; but it is not an oddity of man as such. It is merely an oddity of Primates, the whole order of mammals in which we place apes, monkeys, marmosets and the Tarsier, that anything but missing link between the monkeys and the tree shrews.

Certainly, man is freer to handle things and to examine what he handles because he is erect, but the great apes can at least shamble on two legs. His foothold is much firmer than theirs, but scarcely less so is that of an ostrich. The insertion of his tongue muscles endows him with the power to produce more diverse sounds than the whole gamut of the monkey chorus at sundown when the mosquitoes are about. Assuredly, he has a much bigger brain than any ape, a brain which allows him to cash in on an admittedly unique combination of characteristics not one of which is peculiar to man alone; but when we have said this, there is little more of importance we can say about man's body as a museum piece. It is still a fact that no one single characteristic of man's body labels him as a creature unlike all others. What is unique about man is *his way of life.*

Here we leave the textbooks of zoology behind us, and must bring the archaeologist into the picture. For a period of about a quarter of a million years, we have remains of stones, which we have very good reason to regard as artefacts, i.e. as tools. During this period we have a few fragments of bone, which tell us that there must have existed apes with much bigger brains than those of the chimpanzee or gorilla, apes which could lift themselves from the ground less uncertainly. Of what tools, if any, they were beginning to use we know little with assurance, and we know even less about their folk ways. All we can say with confidence is that there were ape-like creatures before the human story begins, creatures more like men than any apes alive to-day; and here we have to amplify the



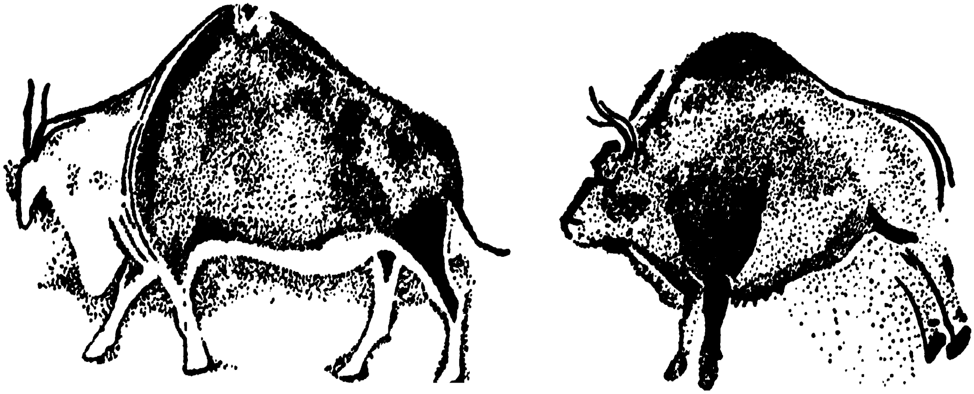
2 *Gorilla, Neanderthaler, Modern Man. The Neanderthalers of the last ice age were more like men than any apes alive to-day. They were both talkative and tool-making, qualities in which man is unique.*

Franklin formula by seeking an answer to the question: were these presumably tool-making ape-men, who have left remains in Java and near Peking, talkative animals in the sense that man alone among living animals is talkative?

Needless to say, man is not, in one sense, the only living animal which is talkative. Monkeys chatter; but there is no percentage in it for them or for us. We can teach parrots, cockatoos, jackdaws, miner birds and budgerigars to make recognisably human noises for our own amusement; but there is no dividend in it for the bird, except a regular supply of food and a cage. Only man makes noises by which he can pass on to his offspring the experience he gains from his tool-making propensities; and we can infer this unique power of *speech* with more than plausibility when the complexity of his way of life leaves in its track enduring relics.

Before the last age when the polar ice-cap stretched down as far as the South of Europe, we have little to go on; but we have now very certain evidence of sub-human life during that period and of the folk ways which went with it. We call these near-humans of the last ice age the Neanderthalers. Their brains were not quite as big as those of real men such as Paul Robeson or Winston Churchill. They were chinless folk with heavy brows. From their leg bones, we know that they walked with a slouching gait, and the lie of the skull tells us that they stooped. With their remains we have flint weapons of the chase, and of no mean workmanship, in fact tools which no animal without the power to hand on experience by associating his cries with action could have made. Besides, they buried their dead and buried them near the hearth. For they had fire.

From all this we can get more than a fleeting glimpse of a society sufficiently novel in the history of life on earth to merit a name of its own. The archaeologist calls the folk ways of these near-human, and still perhaps hairy, hunters of the woolly rhinoceros and the mammoth, the *Mousterian* culture. From its complexity, we can infer that we are now dealing with a Primate with a tradition, a Primate which could both make tools and talk. From the room in the floor of the jaw for attachment of the tongue muscles, we also know that these Neanderthalers could not talk too much; and if they were alive to-day we should talk a lot less about the races of



3 *Quite suddenly, as the last great ice age ended, we meet new men, modern men, much like the yellow-brown smooth-skinned curly-haired Bush folk of South-West Africa. These two drawings (right) from a bison painted perhaps 20,000 years ago in the caves of Altamira and (left) from a Bushman painting at Khotsa, Basutoland, are remarkably alike in style.*

Man. We should realise more clearly why Czech and Negro and Esquimau, even Bushman and Australian can be double-check American. For the Neanderthalers are not yet quite human, as we customarily use the word.

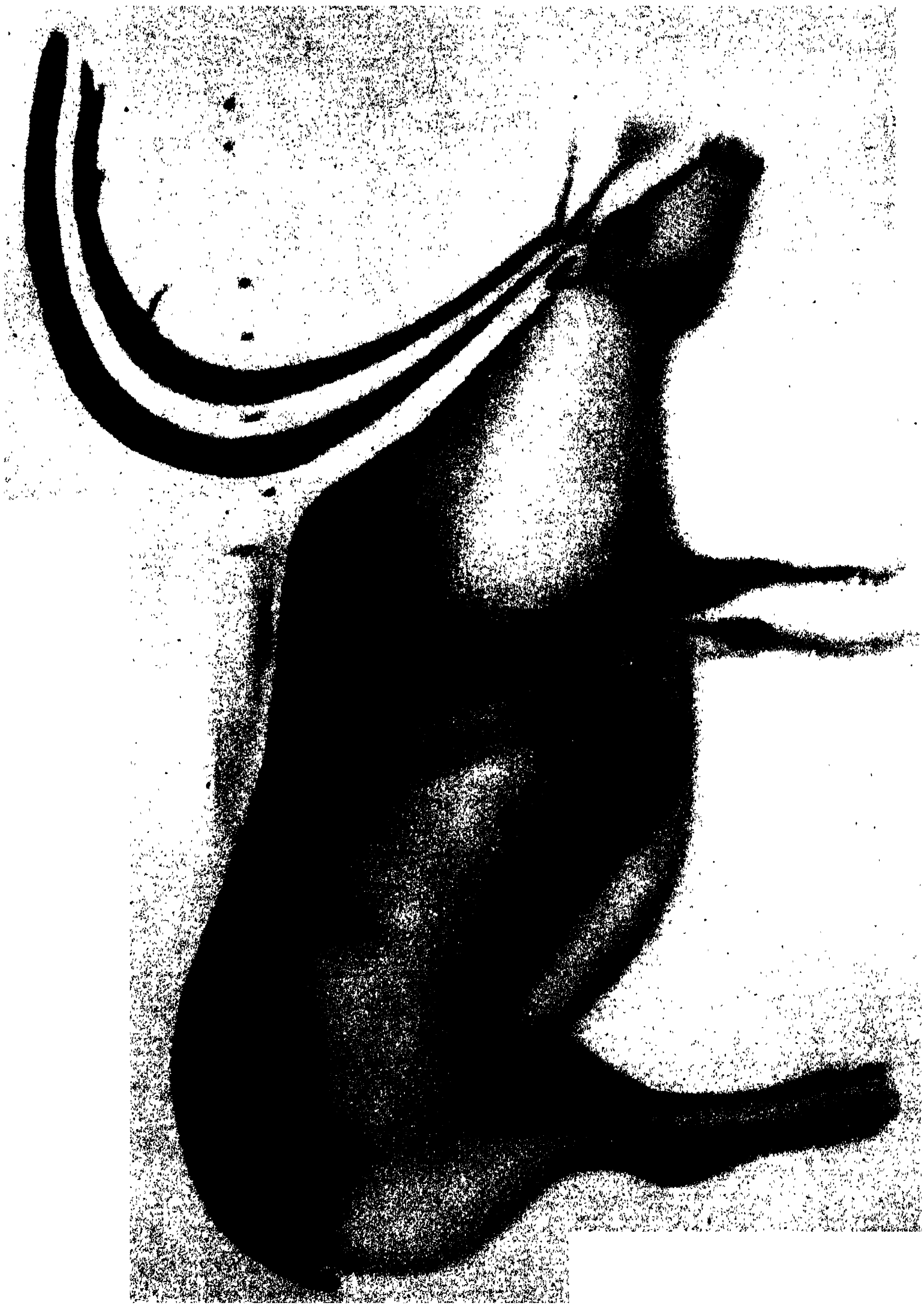
Quite suddenly, at the end of the last great ice age, this Mousterian culture comes to a full stop, somewhere about 30,000 years ago; and quite suddenly we meet new men and new folk ways. The human remains are modern. From their bones and for other reasons which will come later, we can make a shrewd guess that some of them were much like the yellow-brown smooth-skinned curly-haired Bush folk of South-West Africa. If we could reconstruct others in modern dress they could remind us rather of the portraits of the late Mr. Charles Darwin. Where we find them we find an arsenal of tools sufficiently characteristic to warrant a name for their way of life. Mousterian near-man had the spear. These first modern men of the *Aurignacian* culture were hunters who had the bow.

Aurignacian man also made very sharp pointed instruments of flint capable of engraving on stone or on ivory; and the reason we can talk with some confidence both about his folk ways and about how he used such tools is that he could do something quite new. The hunters of the last great ice age could talk a little to one another and could teach their children by talking. They were communicative animals in a sense that is not certainly true of any animals which had lived on earth before; but nothing we know about them leads us to believe that they could communicate action at a distance. The Aurignacian hunters, that is Man in the sense that Tchaikovsky, Charles Dickens and Chiang Kai-shek are men, made pictures. When modern man appears on the stage of pre-history, he is a picture-making animal, the only picture-making animal which has ever lived on our planet, maybe the only picture-making creature in the universe.

Only the vast educational problems of World War II have made us wise to the gigantic implications of this innovation of the evolutionary panorama. Evolution as the biologist uses the term, that is the making of a new species, comes to an end so far as it concerns the student of human affairs. Civilisation now begins with a hallowed silence. Civilisation is not evolution. It is the record of the self-education of the most highly teachable member of the brute creation. Because modern man, and that means post-mousterian man, is a picture-making animal he can communicate without word of mouth. He has already made that terror of modern life the radiogram an unnecessary part of his armoury of self-torture; and has added to his arsenal of self-tuition a new weapon.

This book, which is a picture-book about picture-making, will tell some of the momentous consequences of this fact. So it begins with Man's earliest efforts to educate himself by exploiting his exaggerated—though not unique—powers of vision and learning to use tools in a new way. *From Cave Painting to Comic Strip* is not a book about art, in the customary sense of the term. Indeed, we do not get to grips with the cave paintings and figurines of the Aurignacian hunters, if we conceive their culture classified as art, religion, science or superstition when we should look at their folk ways as a whole. Nor have we a clue to their meaning, if we

1 *When Modern Man appears on the stage of pre-history, he is a picture-making animal, the only picture-making animal which has ever lived on our planet. (Bison, from a later painting in the caves of Altamira, Spain, perhaps 20,000 years old.)*



think that they just painted for fun on the walls of the caves where they lived. To get them into focus let us turn to one of our leading contemporary experts on pre-history. This is what Professor Gordon Childe says about their cave paintings in that intriguing primer *Man Makes Himself*:

> The artist, indeed, surely enjoyed executing them, but he did not do it just to secure that joy. . . . The pictures are generally situated in the deep recesses of limestone caves whither no daylight can penetrate. No families have ever lived in these fastnesses; they are often very difficult of access. And in executing the drawings the artist had often to adopt most uncomfortable attitudes, lying on his back or standing on a comrade's shoulders in a narrow crevice. Of course he had to work by a dim artificial light: the stone lamps have actually been found; fat may be assumed as the fuel with moss for a wick.

Most of us know that the paintings, for they are often coloured sketches traced with ochre and other mineral ores on the cave face, commonly depict animals, and sometimes with astonishing precision and beauty. If we think about them at all we assume that the Aurignacian artist did them because the first modern men earned a livelihood from the chase. To say this is to explain too little or too much; and it leaves material evidence out of account. There is a long tradition of beautiful drawings of animals on rocks, in a style remarkably like those of the cave painters of thirty thousand years ago. They are coming to light more and more in the southern half of Africa; and there is little doubt about the survival of the practice into recent times among the bushmen now nearly exterminated by the Calvinistic settlers who shot them at sight like vermin when they settled in the Cape. Stone and ivory statuettes of the Aurignacian period tell us that the sitters were curly-haired people with very prominent buttocks, as only Bushmen among living men, and no apes, have. The human remains found with the earliest cave paintings also suggest a bush-man type. If so, everything this book contains is the unpaid debt of other modern men to the Bush folk. By the same token, we must take our cue from Bush folk ways, if we hope to get inside the skin of the hunters and food-gatherers who supplanted the Mousterian near-men at the end of the last great glacial epoch.

To do so, we must also be clear about the technical meaning of magic,

II *Astonishing precision and beauty mark many of the cave paintings. Yet the artist generally worked in the deep recesses of caves where no daylight could penetrate and often in most uncomfortable attitudes, lying on his back or standing on another's shoulder. (Reindeer from painting at Font de Gaume, France.)*

or we shall get bogged up in our own language habits. When those who study the habits of preliterate people speak of magic, they do not mean conjuring or even superstition in the sense that scientists of fifty years hence will regard as rank superstition the cosmic blancmange called the ether. They mean something closer to what we also call mascots, charms and scarecrows. Magic as the anthropologist uses the term is the identification of a symbol with the thing it stands for, as when the peasant sticks pins in a wax image of the person who has wronged him. By wearing the lion's skin you endow yourself with the lion's courage and strength. By putting a horseshoe over the door, you keep your foothold on affairs of life. You depict the sun shining on your gatepost, and you ensure a good spell of weather.

This way of conducting life, a world-wide and ubiquitous characteristic of human beings till the tempo of their economy forces them to improvise more freely and frequently, throws some light on a universal habit of pictorial man at the preliterate level, that of tattooing the skin with emblems of one sort or another. It is in this sense that "Cave art has a magic purpose". "The artist", says Childe in the same context,

> scratches upon the blank wall, and lo, there is a bison where formerly there had been none. . . . As surely as the artist drew a bison in the dark cavern, so surely would there be a living bison in the steppes outside for his fellows to kill and eat. To make sure of success, the artist occasionally (but rarely) drew his bison transfixed by a dart, as he desired to see it.

This is not our only clue to the origin of a tradition which has gone on into our own times; and if it were the only *motif* of the cave paintings it would have little relevance to the making of our civilisation. Happily, we have another which ties up with what we know about the folk ways of people who have not made the momentous step of communication at a distance by writing and reading. A few of the earliest cave paintings, like many Egyptian murals and Babylonian seals, show men wearing animal masks of a sort which still-living preliterate people employ in

4 *Only Bushmen among living men, and no apes, have the prominent buttocks shown by the stone and ivory statuettes of the Aurignacian period. (Below) A drawing after Battiss, from a painting of the Mantis Dance in the "Valley of Art", Cape Province. There is a long tradition of beautiful Bushman drawings, such as the lively painting (above) at Witkransspruit, Barkly East, Cape Province.*

tribal ritual; and this tells us much about life in Aurignacian times, as the Bayeux tapestry tells us much about life in medieval Europe.

Such masks are not merely mascots. They are also *signatures* to surnames of a sort. To ourselves a surname has a meaning which presupposes monogamy and a more or less patriarchal family set-up with a powerful rampart of moral prejudice in the background. Among many preliterate people alive to-day, we encounter a different pattern of parent-offspring relationships with a perhaps even more awe-inspiring outfit of moral prohibitions. It is one which sheds a flood of light in the dark caves where the Aurignacian hunters exercised their skill. It helps us to understand their astonishing preoccupation with animals. That the pattern—we call it Totemism—exists all over the world, would almost force us to regard it as a survival of the folk ways of man in the Old Stone Age, if there were no cave paintings to confirm the surmise.

What Freud, in *Totem and Taboo*, says about the Totemic set-up among the Australian blackfellows will suffice to exhibit its essential characteristics:

> Australian tribes are divided into smaller septs or clans, each taking the name of its *totem*. . . . As a rule it is an animal . . . which stands in a peculiar relation to the whole clan . . . its tutelary spirit and protector. . . . The members of a totem are therefore under a sacred obligation not to kill their totem, to abstain from eating its meat. . . . Any violation

5 *Men wearing animal masks, of a sort which still-living peoples use in tribal ritual, are found in some of the early cave paintings. (Left) From a Bushman painting of a nocturnal ritual. (Right) "The Little Sorcerer", drawn after Breuil from a painting in Trois-Frères caves, Ariège, perhaps 16,000 years old.*

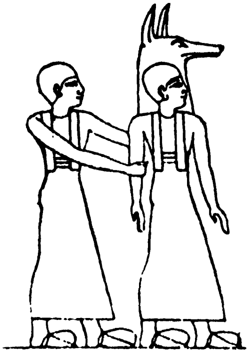
of these prohibitions is automatically punished. . . . From time to time festivals are held at which the members of a totem represent or imitate, in ceremonial dances, the movements and characteristics of their totem.

Although the history of the Scottish clans is still obscure, there are indications of affinity to the same pattern of social relationships. In his book *Scottish Folk Lore and Folk Life* Donald A. Mackenzie tells us:

Kintyre is the home of the MacEacherns, "whose name", Watson says, "is an Anglicization of *Mac Each-thighearna* (Son of the Horse-lord)". The Gaelic word for a horse is *each,* Old Irish *ech*. . . . The Picts were in the north divided into the Orc (boar) and Cat (cat) clans, and Orkney was known to the Irish as *Inse Orcc* (Isles of the Orcs), while Shetland was *Inse Catt* (Isles of the Cats). . . . The Picts had not only dual organization but descent by the female line. . . . Apparently Pictish dualism and mother-right were accompanied by the custom of exogamy, the prohibition of marriage within blood or clan kinship. . . . Dio Cassius tells that when the Emperor Severus was in Scotland his wife, Julia Augusta, had a conversation . . . with a local lady. He says that at the time adultery was so common in Rome that he, when consul, found a list of no fewer than 3,000 cases. Dio writes: "A very witty remark is reported to have been made by the wife of Argentocoxus, a

6 *The early masks were emblems of the tribe, the clan surname, a first signature. This purpose persists in the totems still in use, in heraldry and perhaps in national flags. (Opposite) A carved eagle totem from Vancouver; (above, left) seventeenth-century arms with Sagittarius crest, two-tailed mermaid and satyr supporters; (right) arms of Hastings with man-lion supporter, 1530; (below) stag mask from prehistoric wall-painting in Trois-Frères caves, Ariège, after Breuil and Begouen.*

Caledonian, to Julia Augusta. When the empress was jesting with her, after the treaty, about the free intercourse of her sex with men in Britain, she replied, 'We fulfil the demands of nature in a much better way than do you Roman women; for we consort openly with the best men, whereas you let yourself be debauched in secret by the vilest.' " . . . The MacCodrums of the Outer Hebrides are reputed to be descended from a seal-woman whose "skin covering" had been taken away by an islander. She had to follow this man and he made her his wife. After she had borne children to him, she recovered her "seal



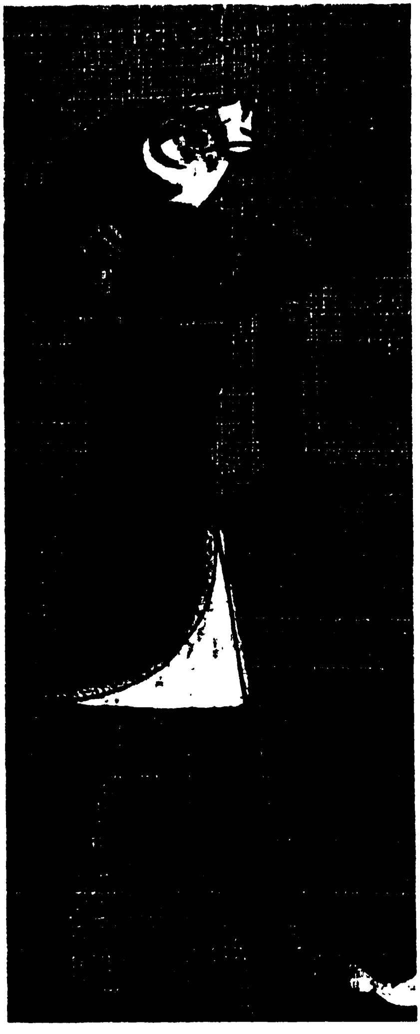
7 *The magic meaning of animal masks also persisted into recorded history. (Opposite) Assyrian relief showing animal dance, with skin-mask (perhaps, much earlier, the origin of clothing). (Above, left) Egyptian priest in the mask of a wolf-god; (right) mermen on a Babylonian seal.*

covering" and returned to her people in the sea. In Gaelic her descendants are known as *Clann 'ic Codrum nan rὸn* ("Clan Codrum of the Seals").

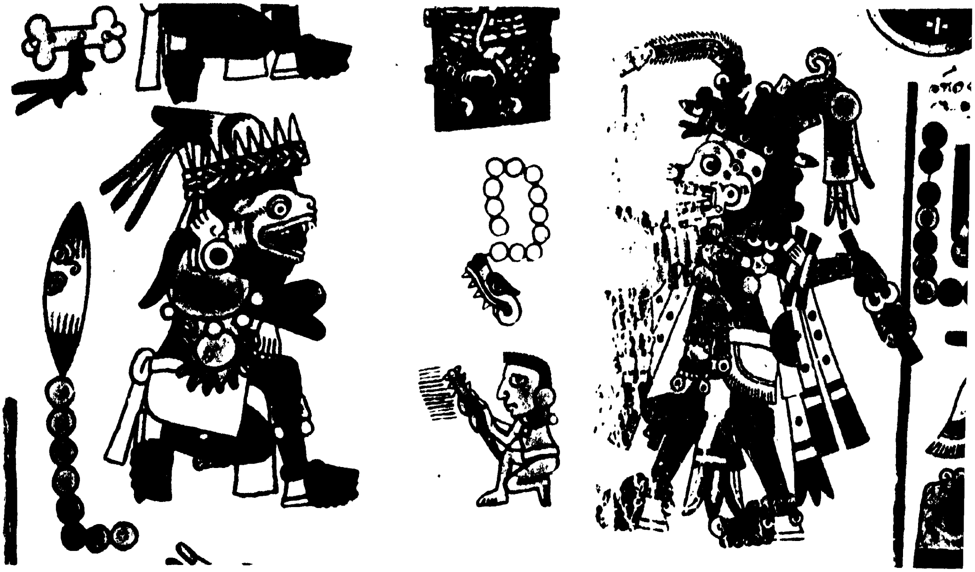
The masks referred to earlier are, of course, part of the equipment for imitating the totem, and we shall need to say more about them later. Let Freud first tell us in what sense the totem is a sort of *surname*:

> The totem is hereditary either through the maternal or the paternal line (maternal transmission probably always preceded and was only later supplanted by the paternal).... Almost everywhere where the totem prevails, there also exists the law that the members of the same totem are not allowed to enter into sexual relations with each other; that is, that they cannot marry each other. . . . Severe punishment is also meted out for temporary love affairs which have not resulted in childbirth. . . . As the totem is hereditary and is not changed by marriage, the results of the prohibition, for instance in the case of maternal heredity, are easily perceived. If, for example, the man belongs to a clan with the totem of the Kangaroo and marries a woman of the Emu totem, the children, both boys and girls, are all Emu. According to the totem law incestuous relations with his mother and his sister, who are Emu like himself, are therefore made impossible for a son of this marriage. . . . The totem accomplishes more. . . . It also makes it impossible for the man to have sexual union with all the women of his own group, with a number of females, therefore, who are not consanguineously related to him. . . .

Since the pioneer work of Frazer in *The Golden Bough* modern classical scholars, such as G. Thomson, the author of a recent treatise on Aeschylus, have found many traces of this pattern of fraternities or clans with an



animal mascot in the civilisations of the Mediterranean, an outcome of modern research beautifully dramatised in the *Golden Fleece* of Robert Graves. We now see that Centaurs and Mermaids are not mythical animals. No more are Dryads. We can read the book of Leviticus as a testament of totemistic prohibitions which have impeded the assimilation of a valuable segment of our community life; and we can trace the



8 *The pattern of totemism is so widespread as to seem certainly a survival of the folk ways of man in the Old Stone Age. (Opposite, left) Egyptian mask from frieze; (right) drawing by Tom Roberts of native of Northern Queensland, with fish mask; (above) Mixtec masked figures from Central America (Codex Zouche-Nuttall).*

bestiality of the Nazi gas chamber to this same bestial obsession. Lest the reader should think that our reconstruction of the cave painters is only conjecture, we may turn again to Gordon Childe, who gives us this vignette of an initiation ceremony of boys entering on manhood in the culture epoch of the first men to use the harpoon:

> In a scarcely accessible niche in the cave of Montespan the mud still preserves the marks left by the buttocks of youths who had squatted there before a magic picture in Magdalenian times.

Let us now try to put ourselves in the shoes of an Aurignacian, though in fact he had none. You yourself, we will say, are a Centaur, that is a member of the clan or fraternity whose mascot is the horse. The lady of your choice—in those days *her* choice—is a lion-woman as Hercules in the Graves interpretation of the Argonaut saga was a lion-man. It is a matter

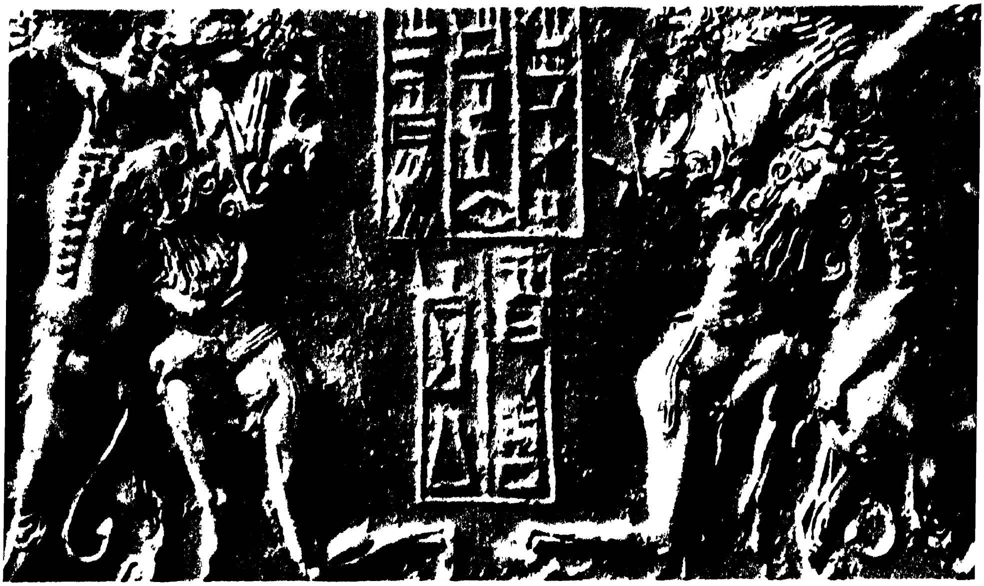
of life or a very unpleasant death by stonecraft, whether you can identify her as of your totem, or then more especially whether she who did the choosing can identify you, as someone of her own totem. At ceremonial orgies associated with *group* marriages before men knew the facts of life, in particular the significance of paternity (still a mystery to the Trobrianders), it was customary to wear an animal mask. It was common to tattoo the skin, or to invest oneself with the skin of one's mascot, a possible explanation of the origin of clothes. In one way or another you have to label yourself with the surname of your clan, as the Scots clans, long since emancipated from their presumptive marital preoccupations when they come on the stage of history, labelled themselves by their tartans, as a Mackintosh, as a Campbell or of the Clan Chattan, that is the Clan of the Cat. One way or another, you must label yourself, or you will add self-injury to incest.

Only now are we beginning to realise what a deep impression this dilemma left on mankind long after the dawn of literacy. There is much to be said for the view that our national flags are totem poles; and that heraldry, in which animal emblems are so prominent a feature, is traceable to devices used by marauding clans to signalise their identity as such. Be that as it may, we are on surer ground when we scrutinise the seals of antiquity. The earliest seal from Susa is a crude animal figure, and if we interpret it as a totemistic signature we discover a direct link between our Bushmen benefactors and two of the cardinal inventions of modern civilisation. The seal is an instrument which contributes a picture symbol to the making of a script, and it is likewise the parent of printing.

How true it is that the seal is the parent of writing and printing, the reader may judge from the following remarks of Dr. Frankfort in his scholarly treatise *Cylinder Seals: a documentary essay on the Art and Religion of the Ancient Near East*:

> It is this use, as a mark of ownership, which explains the curious shape of the cylinder seal. For it is pre-eminently suited to cover varying surfaces with a distinctive design. The legalising of written documents by seal impressions is merely a secondary use of the cylinder,

9 *Peruvian mask worn when invoking the rain-god. The frog symbolised the god of rain, the spots on the face the rain itself.*



10 *The masks developed a significante deeper than the superstition which encouraged their use. They became, in the seals which date from the dawn of recorded history, the first marks of personal ownership, the first picture symbols. These casts of typical seals from Mesopotamia of 3000–500 B.C. show animal masks, animal deities, cuneiform writing and the scorpion of the zodiac.*

understandable since the seal design proved personal ownership.

It is remarkable that the cylinder seal was adopted in Egypt in proto-Dynastic times, almost certainly in imitation of Mesopotamia, and in any case in its original application, for jar sealings. But in the Nile valley the use of papyrus as writing material eventually brought with it a change-over to the more practical form of the signet or stamp-seal, while the retention of clay as the basis of script in Mesopotamia may well account for the parallel retention of the cylinder seal, although the stamp-seal, impracticable for the safeguarding of goods, would serve as well or better for the legalisation of written material.

Yet another application of the cylinder seal as mark of ownership or as trademark is found in Western Asia. The cylinder is sometimes rolled over the shoulder of a jar before the baking, when the clay is still soft—a usage of such obvious efficacy that one wonders at the rarity of its occurrence. . . . It is known at Susa, in the Khabur region, at Byblos, and at Megiddo in Palestine, but not in Mesopotamia proper. Most instances seem to belong to the Early Dynastic period. An interesting modern parallel is supplied by the wooden *roulette* employed by the natives of Nigeria to impress the designs on pots. In Western Asia this usage remains isolated and without consequence, and it throws no light on the origin of the cylinder seal.






The realism and richness of detail in some of the earliest rock paintings of animals is in striking contrast to the crudity of the figure on the Susa seal. Nor need this surprise us. We may assume that no little precision was a necessary part of the magic identification in the earliest phase of man's exploits in picture-making, but such precision would become less and less important through repetition of familiar conventions as time went on. Less and less detail would be essential to recognition, and a simpler, more conventional symbol would be more adaptable to its imprint as a charm on human skin, on the handle of a weapon, on a rude monument to mark the passage of the hunting seasons or on clay vessels baked in the fire.

At what stage we do not know, man's preoccupation with the mascot animal of his clan increasingly assumed a character which has a formative role in the creation of a landed class of calendar-makers with leisure to perfect the use of symbols to record events. Here is what Frazer says about it in *The Golden Bough*:

> Primitive man believes that what is sacred is dangerous. . . . Thus Bechuanas of the Crocodile clan think it hateful and unlucky to meet or see a crocodile. Yet the crocodile is their most sacred object; they call it father, swear by it and celebrate it in their festivals. . . . When a being is thus the object of mixed and implicitly contradictory feelings he may be said to be in a state of unstable equilibrium. In course of time one of the contradictory feelings is likely to prevail over the other. . . . An animal is thus killed as a solemn sacrifice once and once only in the year. . . . He is spared and respected the rest of the year as a god and slain, when he is slain, also in the character of a god.

This unsavoury identification in the twilight of the human reason has a twofold significance for our theme. We have so far spoken of the totemic animal as a surname, like that of Richard Cœur de Lion whose shield displayed the Lion as his emblem. To that extent we may regard the ritual mask or the seal of more settled times as a signature in embryo; but the ramifications of the totemic ideology confer on the picture of the sacred beast another intention which we must later look into more closely. Preliterate man maps the heavens as a guide to his seasonal pursuits.

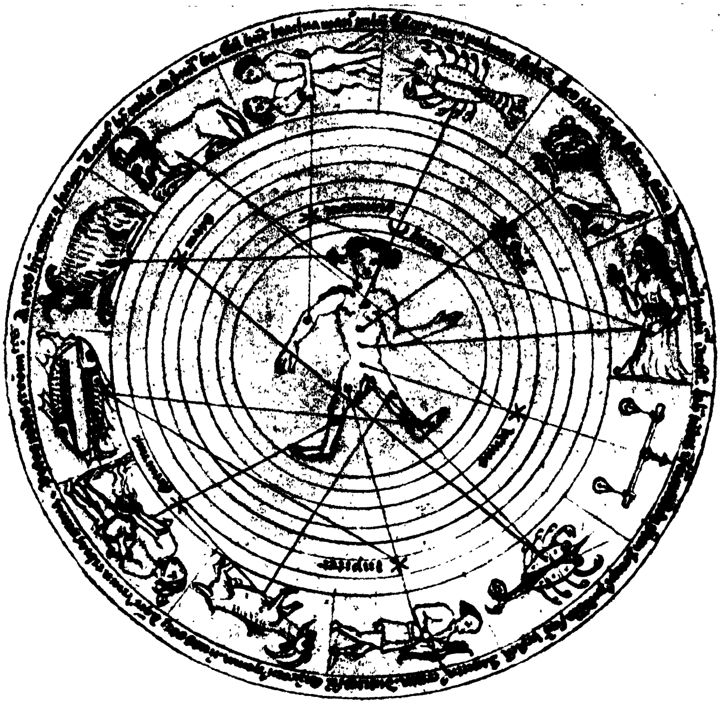
III *Cave art had first a magic purpose. "As surely as the artist drew a bison in the dark cavern, so surely would there be a living bison on the steppes outside for his fellows to kill and eat." (From painting in the caves of Altamira.)*

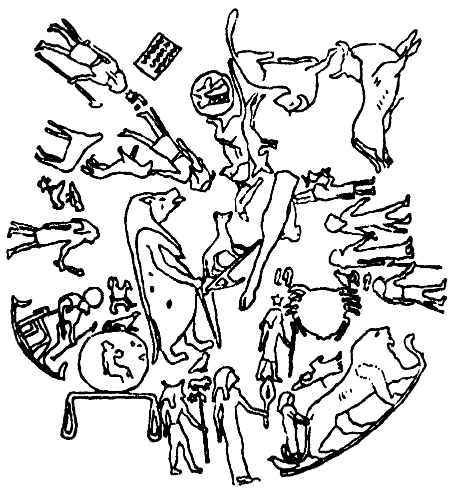
He associates the rising or setting of the sun with a particular star-cluster as a favourable signal for hunting the unforbidden or for the sacrificial ceremony of his tutelary. In this way, totemic signatures of neighbouring clans become the symbols of the first sky map. So the very task of preparing for the ceremony or for the chase at the appointed time forces into the same context the signature of a celestial event and the first crude attempt to record by marks or scratches on stone or wood the lapse of days or months which separate one sky-signal from its predecessor.

What decides the time of the appointed sacrifice, we can at best guess; but a bad guess may bring into focus the momentous step man is about to take as we approach the beginnings of settled community life. It may be that you sacrifice the sacred Ram just before the lambing season begins. The star-cluster whose rising and setting corresponds with that of the sun at the lambing season then has a special relation to your clan surname. In short, it is the constellation of the Ram (*Aries*); and the signature (♈) of the Ram fraternity or sorority now becomes a calendrical hieroglyph. At this stage, it is the task of the wisest old woman of the Ram sorority to keep watch nightly for the time when the sun enters Aries, as it may be that of the wisest old man of the Goat fraternity to keep watch against the day when the sun enters the Goat constellation (*Capricorn*). At first they have to rely on memory; but time comes when permanent settlements, and therewith the two-parent family with a father-surname, permit the separation of a priestly caste with leisure to record the passage of celestial events in a more closely-knit community of interest. The private calendars of the clans coalesce in a common ritual and their signatures, now less necessary as surnames, furnish the priestly sky-watchers with essential ingredients of a priestly script. Here we may turn again with profit to Frankfort's treatise on *Cylinder Seals*:

> Since the seal designs of the First Dynasty of Babylon are as a rule mere conglomerations of figures, we can only deal with its subject-matter by discussing these figures one by one. There is, however, one point of view which would enable us to consider at least the best products of the period as something more than a haphazard collection of motives, assembled

IV *The animal symbols of the prehistoric painter are the earliest clues to the totemistic signatures which were to become, over many thousands of years, the first conventions of human communications. (Boar, from a painting in the caves of Altamira.)*





merely to be distinctive in its variety. It is possible to see in many of the best seal designs an astrological significance. The mediocre and poor seals would, as always, be mere imitations of the better examples and lack a meaning of their own. But . . . it is quite possible to claim that the great gods represent the planets, while the other figures symbolise signs of the Zodiac, either those which according to astrological belief are of special importance because they stood in the Ascendant or in Midheaven at the time of birth, or because they served as "House" to the ruling of other planets. Of the Zodiacal signs in their Babylonian form only two, Cancer and Sagittarius, do not occur on the seals of the First Dynasty of Babylon; Aries, called the labourer, may be represented by the small human figures. Taurus would appear in its usual form; Gemini would be two *talim*, "twins", such as the two nude heroes wrestling (for the denomination of which we have textual evidence) or even hero and Bull-man; Leo appears frequently; Virgo could be represented by any goddess, since her symbol was a woman with an ear of corn and most goddesses were fertility deities. Virgo bore a similar epithet *Banat ributum* "who creates seed"—and was identified with Shala. Libra and Scorpio both occur in their modern form, but Sagittarius appears in the immediately succeeding, Kassite, period, as a Scorpion-man or centaur shooting with bow and arrow. Capricorn, on the other hand, is embodied in Ea's goat-fish, which shape it retains even with us, while Aquarius might well be represented by the nude hero with the flowing vase, which alternates with a female figure similarly equipped; for this constellation, though sometimes treated as masculine, is called Gula, a form of the Mother-Goddess. Pisces, finally, would appear in Babylonia as mermaid and bird ('The Tails').

Thus far man has not discovered the art of writing. For he has not incorporated in his battery of symbols the means of recording the fugitive days and full moons which separate successive milestones in his ceremonial calendar. Man has still to learn to make marks which stand for numbers. These marks are also an essential ingredient of the art of writing; and the sacrificial fantasy plays no mean role in promoting a demand for number symbols. When human life becomes sufficiently settled to permit division of labour, the practice of propitiation by slaying the sacred beast receives a new impetus. It is in the interest of the priestly sky-watchers who prescribe ceremonies appropriate to the season of the year to build up an ideology of sacrifice. By so doing, they can exact tribute on a larger and larger scale. By so doing, they appropriate to themselves land and goods.

11 *The clan symbols attached themselves also to the star clusters which were time-guides to the livelihood and ceremonies of early man. Again the superstition persisted (in astrology); but the symbols also played their part in the coming of the calendar and the priestly scripts. (Below) Central portion of Mesopotamian zodiac of Denderah, first millennium B.C. (Above) With many symbols the same, a zodiac of 1400 A.D.*

By so doing, they promote a new need for recording large numbers.

The coming of the two-parent family itself disposed of an ambiguity inherent in the identification of star-cluster with totem. Henceforth, you are no longer just one of the Goat men begotten of anonymous paternity. You now have the questionable advantage of a father's protection. If his name is Isaac, yours is Isaacson; and if his name is John yours is Johnson. So personal surnames began, as they persist in Iceland to this day; and such is the system to which we can retrace our steps on a solid foundation of fact by a cursory glance at the somewhat tedious genealogies in the Pentateuch. Dog and Lion, Ram, Bull and Goat, Crab, Fish and Scorpion, Great Bear and Little Bear are no longer clan surnames. They are labels of stars and of star-clusters in the night sky.

If we have the inclination to indulge curiosity about the beginnings of family life in the New Stone Age, our only solid basis for speculation is the new light shed by anthropological scholarship on the legends of antiquity. One contemporary writer has tried to penetrate on our behalf a veil of ignorance through which we can at best see darkly. In a book of moving beauty and imaginative erudition, Robert Graves (*The Golden Fleece*) gives us a lively reconstruction of the *mores* of an age in which the cult of the Triple Mother Goddess in her three persons as New, Full and Waning Moon was widespread throughout the Mediterranean. Ancaeus, last survivor of the Argonauts marooned on Majorca, largest of the Hesperides, converses with her priestess in the sacred grove. At first, the conversation is friendly enough:

> She asked him to what fraternity he belonged, and he answered that he was a Dolphin man.
>
> "Ah," said the Nymph. "The very first time that I was initiated into nymph-hood and companied with men, in the open furrow of the field after the sowing, it was with nine Dolphin men. The first of my choice became Sun Champion, or War King, for the ensuing year, as is customary here. Our Dolphins are a small, very ancient fraternity, and distinguished for musical skill even above the Seals."
>
> "The dolphin is delightfully responsive to music," Ancaeus agreed.
>
> The Nymph continued: "Yet, when I bore my child, it was not a girl, to be preserved, but a boy; and in due course back he went, torn in pieces, to the furrow from which he had sprung. The Goddess gave and the Goddess took away again. I have never since

had the heart to company with a Dolphin man, judging that the society is an unlucky one for me. No male child of our family is permitted to live beyond the second sowing season. . . ."

Lucklessly, Ancaeus has a tale to tell of the new father-supremacy of the sun-worshippers in the Isles of Greece, his home:

The Nymph wondered whether she had misheard his words. She asked: "Who may the *Father God* be? How can any tribe worship a *Father*? What are fathers but the occasional instruments that a woman uses for her pleasure and for the sake of becoming a mother?" She began to laugh contemptuously and cried: "By the Benefactor, I swear that this is the most absurd story that ever I heard. Fathers, indeed! I suppose that these Greek fathers suckle the children and sow the barley and caprify the fig-trees and make the laws and, in short, undertake all the other responsible tasks proper to women?" She tapped impatiently with her foot on a stone and the hot blood darkened her face.... "The woman, not the man, is always the principal: she is the agent, he the tool always. She gives the orders, he obeys. Is it not the woman who chooses the man, and overcomes him by the sweetness of her perfumed presence, and orders him to lie down in the furrow on his back, and there riding upon him, as upon a wild horse tamed to her will, takes her pleasure of him and, when she has done, leaves him lying like a dead man? Is it not the woman who rules in the cave, and if any of her lovers displeases her by his surly or lazy behaviour, gives him the three times repeated warning to take up all his gear and begone to his fraternity lodge?"

The nymph has the last word:

Still conversing, she secretly signed to the Goat men that they should take Ancaeus and lead him away from her sight, and then hunt him to death with their slings. For she decided that a man who could relate such disturbing and indecent stories must not be allowed to remain alive on the island, even for a short time longer, now that he had told her what she wished to know about the principle of jointing the wooden statues. She feared what mischief he might do by unsettling the minds of the men. Besides, he was a bent, bald, ugly old fellow, an exile, and a Dolphin man, who would bring no luck to the grove.

The Goat men prostrated themselves in reverence before the Orange Nymph and then, rising up, obeyed her command with joy. The chase was not a long one.

FROM CAVE PAINTING TO COMIC STRIP 2

The Coming of the Calendar

Some sort of writing has existed in the world for about five or six thousand years; and we have seen reason to believe that man had learned to make pictures as symbols, and in a crude sense as signatures, fully twenty thousand years before that. We shall think of the intervening time as a dark age, only if we misconceive the way in which man has had to educate himself. If we traverse quickly a stretch of twenty thousand years or more between man's first exploits in picture-making and the first crude settlements of the New Stone Age, we have to do so because his next assignment in self-education was one which it would have been impossible to accomplish without centuries of painstaking observation dictated partly by the discipline of struggle with external nature, partly by forebodings and hopes seemingly foolish in retrospect.

At the outset, we must dismiss the idea that the first men equipped with the art of writing had any prevision of its consequences as a medium of communication at a distance. The convenience of being able to send messages by symbols is obvious only to those who have had the experience of its advantages; and people are ever slow to adapt their means of communication to their own profit. Even to-day, British schoolchildren have the handicap of an extra school year's work because no one can induce the British Parliament to adopt a decimal system of coinage, weights and measures widely used throughout western civilisation. It is therefore silly to suppose that early discoveries came about by the sort of foresight which fostered the fission of the atom.

In the study of primitive cultures we must always be suspicious of explanations which rely on motives imputing prevision of the profit a new technique may confer. For instance, it is most unlikely that human

12 *Forecasting the seasons is a physical necessity for nomadic hunters and food-gatherers. These Kenyah tribesmen of Borneo are measuring the shadow cast by a stick of fixed length at noon on successive days. When the shadow begins to shorten from its maximal length the time for preparing the land is near at hand.*

beings invented clothes in order to explore new hunting grounds in colder climates. More probably they blundered into wearing clothes for a variety of reasons which we can at best surmise. Archaeologists have advanced several suggestions. One relies on the fact that Primates, unlike most other mammals, have no *retractor penis*, a circumstance of some inconvenience to the male of a species which adopts the upright posture. Thus some sort of waist-band to remedy this disability may well have been the first contribution to the human wardrobe, though the totemistic hypothesis mentioned in the last chapter offers a far more satisfactory explanation of how man furnished his wardrobe with a kit of bearskins or horsehides for foreign travel.

To understand how man accomplished his first school tasks, we have always to seek for some immediate and compelling necessity imposed on him by his surroundings or by his own make-up. We have seen in man's own make-up a motive for his first urge to make pictures; and we shall now see what external circumstances imposed on him the need to keep a record. The main outlines are clear. Only the priorities are open to dispute; and there is no doubt about the identity of one impelling urge to record events in the everyday life of a preliterate community. While writing as a means of transmitting a message is a convenience, writing as a means of recording events is a necessity, if only because time flies and the human memory is short. We are not born with a knowledge of the calendar, or with any direct means of fixing our bearings in space; but discovering how to forecast the seasons and how to trek to a hunting ground was already a physical necessity of life for the nomadic hunters and food gatherers who appear on the stage of history at the end of the last great ice age. They had to learn where food of different sorts was abundant at different seasons and how to trek thither at the right time. We may be sure that they had a star-lore of a sort which would astonish most city dwellers who get their knowledge of nature from books, unable to share the wonder of Job when asked: "Canst thou bind the sweet influences of Pleiades or loose the bands of Orion? . . . canst thou guide Arcturus with his sons?"

 All preliterate people living to-day have such knowledge; as have

13 *When written history begins man is already an astronomer with the experience of twenty thousand years of season-forecasting behind him. This Babylonian zodiac dates from the second millennium B.C.*

country folk who can see a sky line unimpeded by neon lights and the roof of an apartment block. As the most backward people of to-day do, the hunters and food-gatherers of the Old Stone Age would note where the Pleiades, where Arcturus, where Sirius or where Canopus rise just before sunrise or set just after sunset and what weather, what berries ready for plucking, what quarry in foal, or what birds nesting on their eggs the heliacal rising and setting of each bright star portends. In an important monograph entitled *Primitive Time Reckoning* this is what

Nilsson tells us about the way in which preliterate peoples of the present day regulate their lives by star-lore:

> Primitive man rises and goes to bed with the sun. When he gets up at dawn and steps out of his hut, he directs his gaze to the brightening east, and notices the stars that are shining just there and are soon to vanish before the light of the sun. In the same way he observes at evening before he goes to rest what stars appear in the west at dusk and soon afterwards set there. Experience teaches him that these stars vary throughout the year and that this variation keeps pace with the phases of Nature, or, more concretely expressed, he learns that the risings and settings of certain stars coincide with certain natural phenomena. . . . Just as the advance of the day is discerned from the position of the sun, so the advance of the year is recognised by the position of certain stars at sunrise and sunset. . . . In order to determine the time of certain important natural phenomena it is therefore sufficient to know and observe a few stars or constellations with accuracy and certainty. The Pleiades are the most important. . . . The Hottentots connect the Pleiades with winter. These stars become visible in the middle of June, that is in the first half of the cold season, and are therefore called "Rime-stars", since at the time of their becoming visible the nights may be already so cold that there is hoar-frost in the early morning. The appearance of the Pleiades also gives to the Bushmen of the Auob district the signal for departure to the *tsama* field. . . . A tribe of Western Victoria connected certain constellations with the seasons. . . . The winter stars are Arcturus—who is held in great respect since he has taught the natives to find the pupae of the wood-ants, which are an important article of food in August and September—and Vega, who has taught them to find the eggs of the *mallee*-hen, which are also an important article of food in October. The natives also know and tell stories of many other stars. Another authority states that they can tell from the position of Arcturus or Vega above the horizon in August and October respectively when it is time to collect these pupae and these eggs. . . . For example when Canopus at dawn is only a very little way above the eastern horizon, it is time to collect eggs; when the Pleiades are visible in the east a little before sunrise, the time has come to visit friends and neighbouring tribes. The Chukchee form out of the stars Altair and Tarared in Aquila a constellation named *pchittin*, which . . . begins to appear above the horizon at the time of the winter solstice . . . and most families belonging to the tribes living by the sea bring their sacrifices at its first appearing. . . . In north-west Brazil the Indians determine the time of planting from the position of certain constellations, in particular the Pleiades. If these have disappeared below the horizon, the regular heavy rains will begin. The Siusi gave an accurate account of the progress of the constellations, by which they calculate the seasons, and in explanation drew three diagrams in the sand. No. 1 had three constellations:—"a Second Crab", which obviously consists of the three bright stars west of Leo, "the Crab", composed of the principal stars of Leo, and "the Youths", i.e. the Pleiades. When these set, continuous rain falls, the river begins to rise, beginning

of the rainy season, planting of manioc. No. 2 had two constellations:—"the Fishing Basket", in Orion, and *kakudzuta*, the northern part of Eridanus, in which other tribes see a dancing-implement. When these set, much rain falls, the water in the river is at its highest. No. 3 was "the Great Serpent", i.e. Scorpio. When this sets there is little or no rain, the water is at its lowest. The natives of Brazil are acquainted with the course of the constellations, with their height and the period and time of their appearance in, and disappearance from the sky, and according to them they divide up their seasons. . . . In Africa also the observation of the stars, and above all the Pleiades, is widespread. . . . The Melanesians of Banks Island and the northern New Hebrides are also acquainted with the Pleiades as a sign of the approach of the yam-harvest. The inhabitants of New Britain (Bismarck Archipelago) are guided in ascertaining the time of planting by the position of certain stars. The Moanu of the Admiralty Islands use the stars as a guide both on land and at sea, and recognise the season of the monsoons by them. When the Pleiades (*tjasa*) appear at nightfall on the horizon, this is the signal for the north-west wind to begin. But when the Thornback (Scorpio) and the Shark (Altair) emerge as twilight begins, this shews that the south-east wind is at hand. When "the fishers' Canoe" (Orion, three fishermen in a canoe) disappears from the horizon at evening, the south-east wind sets in strongly: so also when the constellation is visible at morning on the horizon. When it comes up at evening, the rainy season and the north-west wind are not far off. When "the Bird" (*canis major*) is in such a position that one wing points to the north but the other is still invisible, the time has come in which the turtles lay eggs, and many natives then go to the Los-Reys group in order to collect them. The Crown is called "the Mosquito-Star", since the mosquitoes swarm into the houses when this constellation sets. The two largest stars of the Circle are called *pitui* and *papai*: when this constellation becomes visible in the early morning, the time is favourable for catching the fish *papai.* The natives of the Bougainville Straits are acquainted with certain stars, especially the Pleiades: the rising of this constellation is a sign that the *kai*-nut is ripe: a ceremony takes place at this season. On Treasury Island a grand festival is held towards the end of October, in order—so far as could be ascertained—to celebrate the approaching appearance of the Pleiades above the eastern horizon after sunset. In Ugi, where of all the stars the Pleiades alone have a name, the times for planting and taking up yams are determined by this constellation. In Lambutjo the year is reckoned according to the position of the Pleiades.

Around the camp fire and on their twilit errands of the chase the hunters and food gatherers of the Aurignacian and Magdalenian epochs would thus learn to map the heavens by the track of groups of stars which they would associate in one or another way with the Totemic menagerie. They would begin to date occurrences by the waxing and waning of the moon. The old women and the old men of the tribe would recall a girl or boy as born so many moons (30-day time units) ago, and hence ready for the ceremonial initiation into womanhood or manhood. Age was an awe-inspiring repository of tribal wisdom before man had collectivised his memory by the creation of a script. The oldest woman or the oldest man of the tribe was the most comprehensive calendar, the master clockmaker, the Registrar General of births and deaths, the dictionary of national biography and the chief surveyor of the tribe. Nilsson, among whose pages we have browsed already, tells us how some sort of specialisation of responsibility for the calendar exists among living preliterate people in the following words:

> Some of the Bontoc Igorot state that the year has eight, others a hundred months, but among the old men, who represent the wisdom of the people, there are some who know and assert that it has thirteen. The further the calendar develops, the less does it become a common possession. Among the Indians, for example, there are special persons who keep and interpret year-lists illustrated with picture-writings, e.g. the calendrically gifted Anko, who even drew up a list of months. . . . Among the Caffres we read of special "astrologers". Among the Kenya of Borneo the determination of the time for sowing is so important that in every village the task is entrusted to a man whose sole occupation it is to observe the signs. He need not cultivate rice himself, for he will receive his supplies from the other inhabitants of the village. His separate position is in part due to the fact that the determination of the season is effected by observing the height of the sun, for which special instruments are required. The process is a secret, and his advice is always followed. It is only natural that this individual should keep secret the traditional lore upon which his position depends; and thus the development of the calendar puts a still wider gap between the business of the calendar-maker and the common people. Behind the calendar stand in particular the priests. . . . Among the priests there is formed a special class whose duty it is to make observations and keep the calendar in order. Among the Hawaiians "astronomers (kilo-hoku) and priests" are mentioned; they handed down their knowledge from father to son; but women, *kilowahine*, are also found among them. Elsewhere the nobles appear alongside of the priests; thus in Tahiti it is the nobles who are responsible for the calendar, in New Zealand the priests. In the latter country there is said to have been a regular school, which was visited by priests and chiefs of highest rank. Every year the assembly determined the days on which the corn must be sown and reaped, and thus its members compared their views upon the heavenly bodies. Each course lasted from three to five months.

It is not remarkable that man is an astronomer when the written record of human history begins. It would be more remarkable if man could have amassed the experience which delimited the Egyptian year in a shorter period than the twenty-odd thousand years which separate the first cave paintings from the beginnings of civilisation. Indeed, we can make more than a shrewd guess about how he accomplished the task and about some of the consequences of the way in which he did so. In broad outline our reconstruction of the stages does not have to rely on what we can surmise by analogy with the practice of contemporary hunting and food-gathering folk who have not yet learned to write and to read. Written history starts on a note of controversy between two schools, the Mesopotamian moon-timekeepers with a 360-day year of twelve thirty-day months and the Egyptian sun-time innovators with their year of 365 days and a bit. Everything their legends and ritual suggest about their temples as observatories of celestial events tallies with what astronomers can deduce from their lay-out. More than that, the lay-out of monuments such as Stonehenge built by folk who carried the sun-calendar far north, and started on their trek long before writing began, tells the same tale. This is what the astronomer Sir Norman Lockyer says about the Stonehenge set-up:

> It has long been known that Stonehenge is oriented to the rising of the sun at the summer solstice. Its amplitude instead of being 26° is 40° N. of E.; with a latitude of 51°, the 26° azimuth of Thebes is represented by an amplitude of 40° at Stonehenge. The structure consists of a double circle of stones, with a sort of naos composed of large stones facing a so-called avenue, which is a sunken way between two parallel banks. This avenue stretches away from the naos in the direction of the solstitial sunrise. But this is not all. In the avenue, but not in the centre of its width, there is a stone called the "Friar's Heel", so located in relation to the horizon that, according to Mr. Flinders Petrie, who has made careful measurements of the whole structure, it aligned the coming sunrise from a point behind the naos or trilithon. The horizon is invisible at the entrance of the circle, the peak of the heel rising far above it; from behind the circles the peak is below the horizon. Now, from considerations which I shall state at length further on, Mr. Petrie concludes that Stonehenge existed 2000 B.C. It must not be forgotten that structures more or less similar to Stonehenge are found along a line from the east on both sides of the Mediterranean. It will be seen that the use of the marking stone to indicate the direction in which the sun will rise answers exactly the same purpose as the long avenue of majestic columns and pylons in the Egyptian temples. In both cases we had a means of determining the commencement and the succession of years. Hence, just as surely as the temple of Karnak

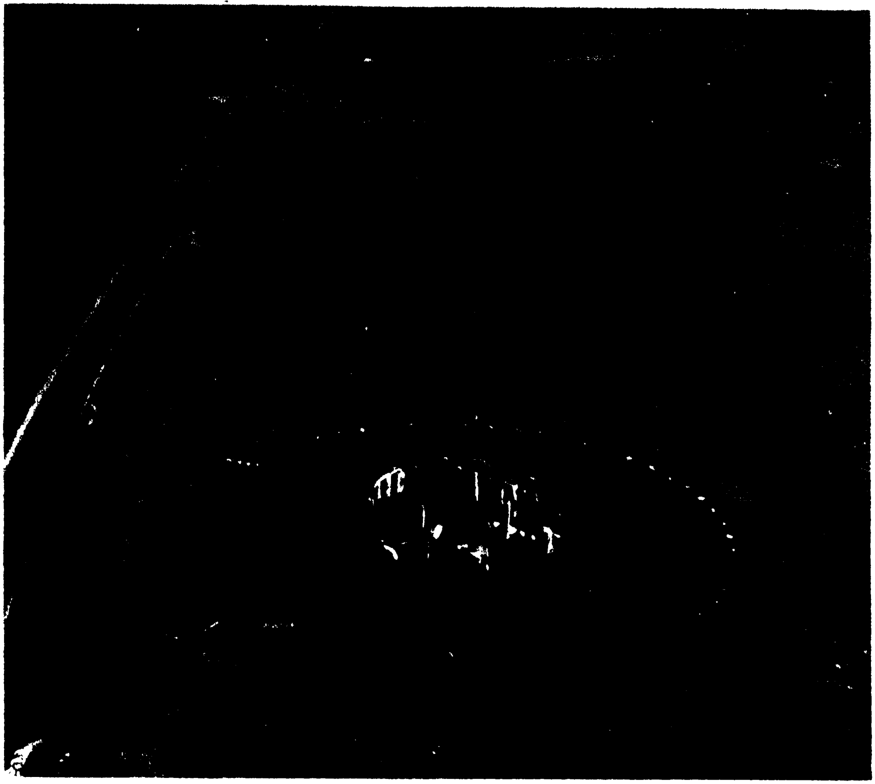
once pointed to the sun *setting* at the summer solstice, the temple at Stonehenge pointed nearly to the sun *rising* at the summer solstice. Stonehenge, there is little doubt, was so constructed that at sunrise at the same solstice the shadow of one stone fell exactly on the stone in the centre; that observation indicated to the priests that the New Year had begun, and possibly also fires were lighted to flash the news through the country. And in this way it is possible that we have the ultimate origin of the mid-summer fires, which have been referred to by so many authors.

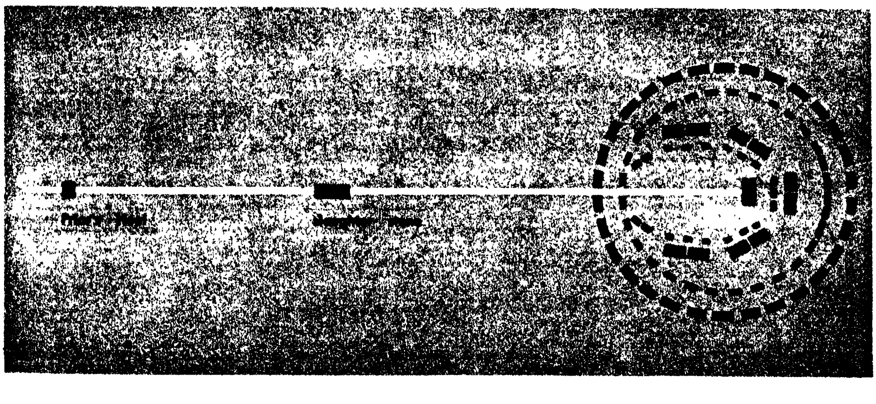
In his book *Comparative Religion*, Bouquet tells the same story of the menhirs (stone pillars) set in rows in Britain in Cornwall, on Dartmoor, on Exmoor, in the Scottish highlands and in the North Riding of Yorkshire, as also in Brittany,

> arranged in a manner almost identical with those of the Khasis and Nagas of Assam. One very ingenious etymological theory makes the name of the god Apollo connect with the word "pella", which is a Greek synonym for the better-known word "lithos", a stone, and "pella" is by Grimm's law the same as the German "Fels", a rock. We have actual record of the connexion of Apollo with certain menhirs. . . . Stone circles are connected quite as much with open-air sky-worship as with the burial and cult of the dead, and it is remarkable that they are distributed over an area ranging from the British Isles to Peking, and including Africa, Italy, Scandinavia, Persia, Arabia and the North-west frontier of India. Stone-circles, avenues and menhirs are by no means all of the same age, any more than Gothic churches are. The practice of making them may well have prevailed through several millennia; and the most highly developed circle, the well-known white-marble Altar of Heaven at Peking, was erected as recently as 1889. Recent investigations have shown that the stone circle is related to the wood circle. . . . Thus the grove is conventionalised into a circle of posts, and the posts become megalithic uprights.

It is a far cry from the primitive astronomy of the Bushman or of the Australian aborigines to a temple observatory of the Bronze Age, such as that of Stonehenge, or of wooden groves which presumptively antedate calendrical monuments still extant; but the existence of two calendars in Egypt leaves us in little doubt about the sequence of calendrical invention between the Cave painters of the Aurignacian culture and the beginning of civilisation on the Nile. The Egyptians had two years, one of 365 days, the *Sothic* based on the heliacal rising of the dog star Sirius, brightest of all stars in the heavens. Of the other, we shall have more to say at a later

14 Temple observatories were built by folk who carried the sun-calendar far north. At Stonehenge (2000 B.C.) on the morning of the summer solstice, the sun rising behind the Slaughter Stone was aligned by the Friar's Heel Stone to a point within the sanctuary. It was the signal that the New Year had begun.

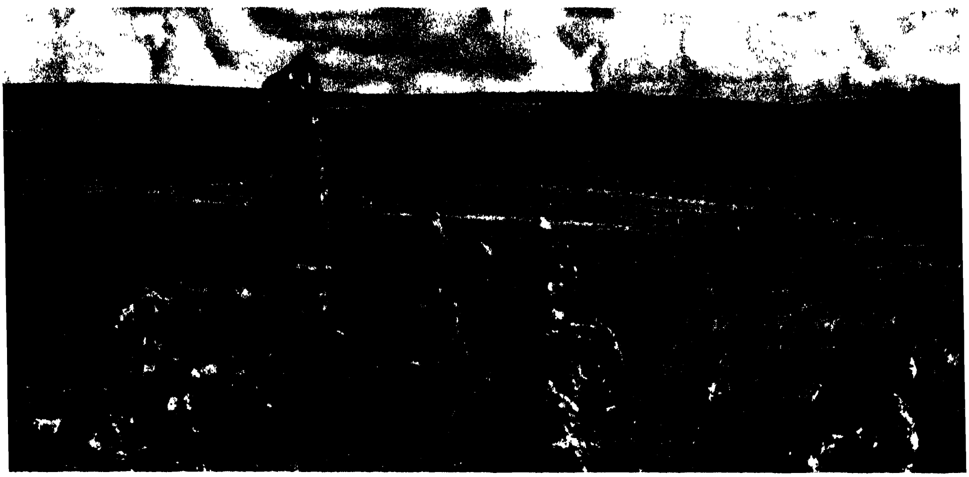




15 From Peking to Britain stone circles, avenues and menhirs were built over a period of several millennia to serve as astronomical observatories. (Above) The stones at Carnac, Brittany. (Opposite) The majestic columns of the avenue at Karnak, Egypt, down which the rays of the setting sun shone directly on the evening of the summer solstice.

stage. The sidereal year started on the day when Sirius is just rising in the first flicker of dawn. A year delimited in this way is on all fours with widespread custom among living preliterate peoples, as Nilsson has assured us; and early Mesopotamian calendar-lore likewise ties up with contemporary practice at the preliterate level of life. Before men made marks to count off the days between the dawn-rising or sunset-setting of a star on successive occasions, they had learned to map the position of the rising and setting sun on the horizon by the rising and setting position of star-clusters whose surviving names—the Ram, the Bull, the Lion, the Goat, the Fish, the Crab and the Scorpion—are eloquent testimony to the role of the calendar in the Totemic ritual and hunting pursuits of an age vastly earlier than the date of the first Euphratean settlements.

Such testimony is all the more eloquent because the division of the firmament into the star-clusters of the zodiac derives no very obvious sanction



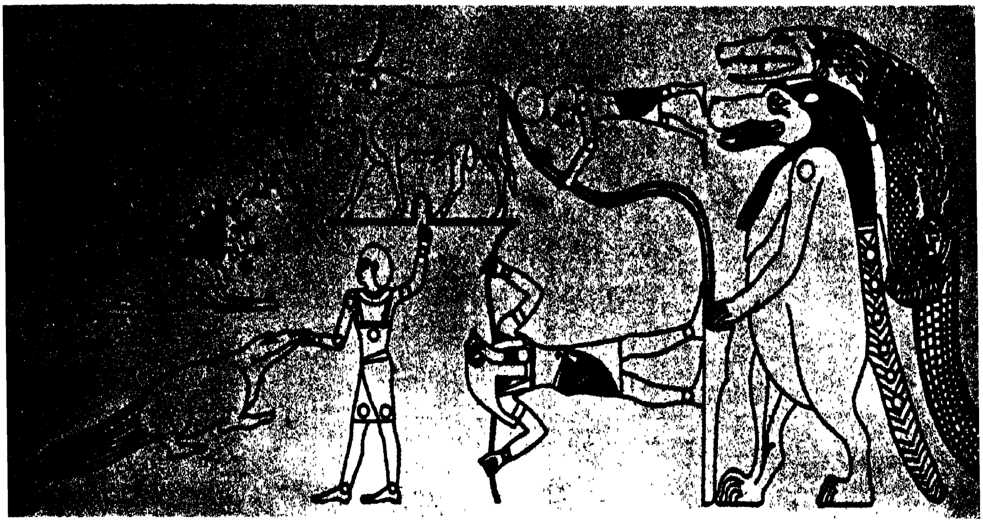
16 The Bronze Age observatories are a far cry from the first primitive astronomy. They enable the observer to note the interval between two occasions when the sun rises at exactly the same point of the horizon, and so, possibly, to delimit the tropical year of 365¼ days. (Stone avenue, Down Tor, Devon.)

from the appearance of the night sky; and would seem quite arbitrary if we had no clue to the motives which impelled early man to map the heavens. We have found the clue in our first chapter. The earliest calendar-lore of the Euphrates discloses a zodiac of only six signs: *Taurus, Cancer, Virgo, Scorpio, Capricornus* and *Pisces,* all but one of which are sacred animals. At this stage, we thus see a solar calendar emerging against a background of units sufficiently small for the memory to deal with. Two months of 30 days define the lapse of time between the sun's entry into one zodiacal constellation and the next; and the collective year of these several clan calendars is a 360-day cycle of 6 double months, i.e. 2 moon units of 60 days in all. The complete zodiacal circus, which maps the later year of the Mesopotamian priesthoods as a cycle of 12 months, arrives on the scene after the coming of a priestly caste of calendar-makers.

To say that the sun enters Capricorn on a certain day signifies that some chosen star in the constellation of the Goat is just visible above the horizon before dawn where the rising sun is about to appear. Ram, Bull and Lion, Goat (Capricorn), Crab (Cancer) and Scorpion are labels which proclaim the close association of man's lessons in timekeeping with his totemic ritual and daily struggle for food in an age when he was still a nomadic hunter; but they also point to a shift of emphasis as we approach the beginnings of settled life. More and more man's outlook turns upwards; and legend suggests that his totem signatures take on a new use. If you are a man or woman of the Goat fraternity, your ceremonial year will begin when the sun enters Capricorn; and if you have started a more settled sort of life than that of the first cave painters, you will mark the site of its rising with stone pillars or saplings to guide the ritual procession which greets it with the sacrifice of the sacred beast. Your goat emblem is now a symbol for a unit of time, for an aspect of the heavens and for a horizon bearing.

To appreciate the significance of the Stone avenues which label the sun's rising or setting position on the day announcing the beginning of a New Year, it is necessary to know a little astronomy. Fortunately, the great excavators such as Flinders Petrie were themselves good astronomers, having taken to research before universities handed out diplomas of competence in watertight specialities; and on that account they were able to interpret intelligently the technical problems which man is in process of solving as we approach the threshold of the New Stone Age. Let us therefore look at the astronomical problems for which mankind is seeking a solution on the threshold of the Neolithic Revolution.

We have seen that the Egyptians recognised a 365-day year based on the heliacal rising of Sirius. It is now necessary to examine the implications of the fact that they also had a 365¼-day year based on observations of a different sort. The two systems of sun-time correspond to what modern astronomers distinguish respectively as the sidereal and the tropical year. The sidereal year is the interval between two occasions when the sun returns to its previous position among the fixed stars in the course of its apparent annual trek in the zodiacal belt. Any star or star-cluster serves to fix it roughly, as the Egyptians fixed the Sothic year; and this is possible at a very primitive level. The tropical year signifies the interval between two



17 In the star maps of Ancient Egypt, the sacred animal (or clan totem) still symbolises an aspect of the heavens. This chart of the stars in the region of the Pole is from a wall-painting in the tomb of Seti I, made about 1300 B.C.

occasions when the sun rises at exactly the same point on the *horizon;* as for instance its extreme northerly limit (summer solstice), its extreme southerly limit (winter solstice) or half-way position at the vernal and autumnal equinoxes. Fixing the length of the tropical year is not exactly the same as fixing the sidereal year, because the earth wobbles on its axis like a spinning top, making a complete cycle in the course of 25,000 years. On this account the rising and setting position of a fixed star with reference to the horizon changes slowly in the course of centuries, and a calendar which dates the year from the day on which the sun's rising position corresponds with that of a particular star gets annually a little bit more out of step with the seasons which depend only on the sun's rising or setting position relative to the *horizon itself.*

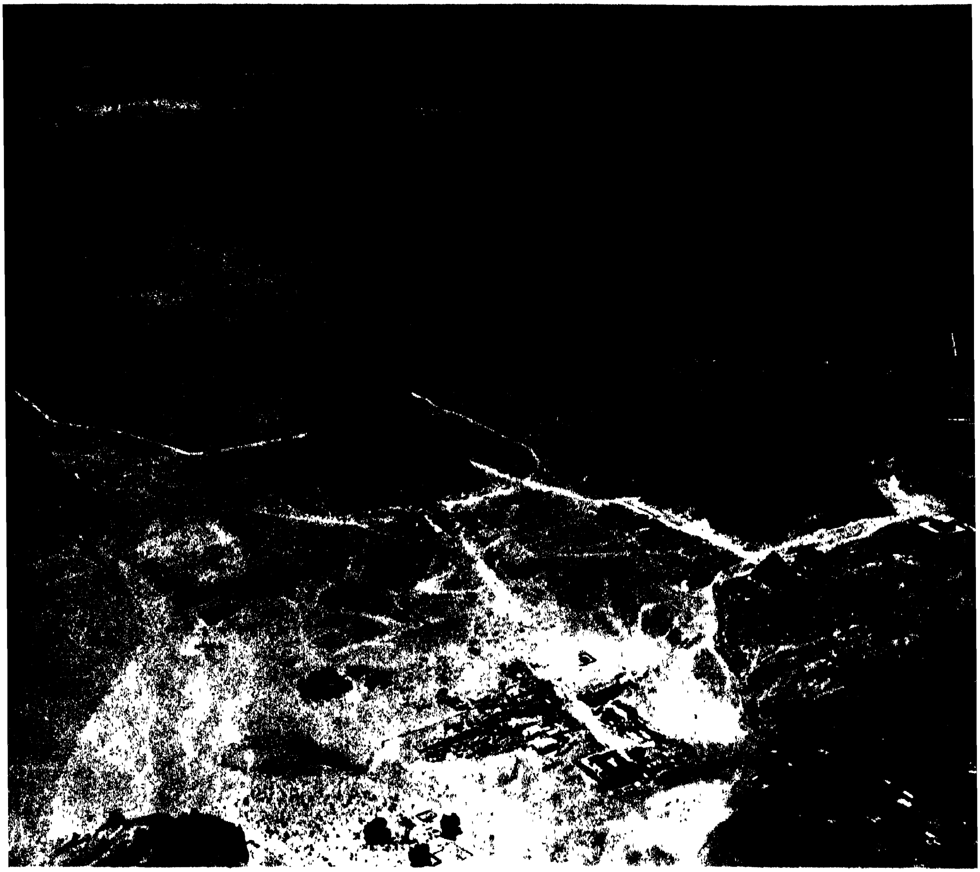
Centuries, maybe millennia, of painstaking observation of the rising and setting of the sun preceded the time when written history begins in Egypt and Mesopotamia. In *The Legacy of Egypt* Sewell tells us:

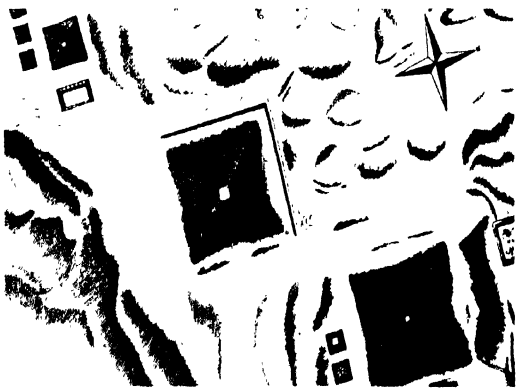
The question may be asked, indeed has been asked, whether it is credible that a people

18 *The signs of the zodiac derive no obvious sanction from the appearance of the night sky. Taurus, which has the outline of a bull in the sixteenth-century drawing (right), can equally well be given some quite different outline as in the modern imitation (left). The name came first, the outline later.*

whose writing was in its infancy at the opening of dynastic history should be capable of astronomical observations and computations. The primary answer is that there is ample evidence that they actually did make surprisingly accurate observations. It is unnecessary to offer conjectures as to the method adopted for observation of an equinox, since the only reasonable inference from the evidence is that they knew the length of a year measured from autumn equinox to autumn equinox within one or two minutes. Such accuracy could be attained only by the use of records which showed the interval which had elapsed between autumn equinoxes, for example, 100 years apart.

To get into perspective what the knowledge of the tropical year at so early a stage in the human record portends, we must liberate ourselves from the hypnotic power of a formula. As children we have heard too often that the sun rises in the east and sets in the west. Consequently most of us have to make an effort to remember that this happens only on two days of the year, the Easter and the Harvest equinoxes, each redolent of agelong association with fertility rites. To fix East and West by the sun alone, we have to bisect the angle between a fixed point on the landscape and the sun's rising or setting position on the solstices,





19 *Long ages of sky observation were required to establish a calendar, both in the Old World and the New. The east-west layout of the Pyramids of Gizeh enabled the Egyptians to observe the equinoxes. The Aztecs used the 365-day solar year in addition to the arbitrary 260-day "sacred" year. The inner circle of the Mexican Calendar-Stone (above) shows the 20 Mexican day-signs.*

that is the dates of its furthest northerly and of its furthest southerly goal in its apparent annual trek to and fro across the heavens. To fix North and South by the sun alone, we have to bisect an angle between the lie of the sun's shadow at some time before noon and the lie of the sun's shadow of *equal length* at some time after noon. Either way, we have to be able to bisect an angle, to trace a circle in soft earth or sand with a piece of cord or otherwise and to make a set-square of sorts. When we have learned to do so we have not merely become better astronomers. We have also started to teach ourselves geometry.

To do anything of the sort, we have to set up some pole or stone to mark where the sun is on a particular day, and it is possible that men started doing this sort of thing to guide them in their nightly expeditions or to label the site of a ceremonial which transfers its emphasis from the totem to the calendar as the social life of early man becomes more closely knit. What we know with some assurance is that the men who trekked northward with the knowledge of sun-time made stone avenues to greet the rising or setting of particular stars; and what archaeology encourages us to infer tallies with what we know about sun-timekeeping among preliterate people still alive. Writing of the devices they use to map the track of the rising and setting sun across the horizon during the course of the tropical year, Nilsson remarks:

> . . . the observation of the solstices and equinoxes belongs to a much higher stage of civilisation than does that of the stars. . . . It is used by the Eskimos, who have a very highly developed sense of place, and know how to make good maps. Moreover where the sun in winter stands very low on the horizon, and for a time altogether disappears beneath it, the conditions are very favourable for the observation of its return. Older authors say that by the rays of the sun on the rocks the Eskimos can tell with tolerable accuracy when it is the shortest day; more recently we have been told of the Ammasalik that they can calculate beforehand the time of the shortest day—and that accurately to the day—not only from the solstitial point, but also from the position of Altair in the morning twilight. They begin their spring when the sun rises at the same spot as Altair. . . . One would suspect that this Melanesian science, like the knowledge of the stars, is borrowed from the Polynesians: for the latter understood the annual course of the sun. In Tahiti the place of the sunrise was called *tatalieita*, that of the sunset *topa-t-era*. The annual movement of the sun from the south towards the north was recognised, and so was the fact that all these points of the daily approach to the zenith lay in a line. This meridian was called *t'era-hwattea*, the northern point of it *tu-errau*, and the opposite point above the horizon, or the south, *toa*. According to other sources the December solstice was called *rua-maoro* or *rua-roa*, the June solstice *rua poto*. . . . How the Polynesians came to recognise the tropics and the equator is unfortunately unknown, but certainly they did it like other peoples by observing the solstices and equinoxes at certain landmarks. . . . Agricultural peoples in particular have developed various methods of this kind. The rice-cultivating

peoples of the East Indies use various methods in order to determine the important time of sowing. Of the observation of the stars we have already spoken. Among the Kayan of Sarawak an old priest determines the official time of sowing from the position of the sun by erecting at the side of the house two oblong stones, one larger and one smaller, and then observing the moment when the sun, in the lengthening of the line of connexion between these two stones, sets behind the opposite hill. The sowing-day is the only one determined by astronomical methods. In other respects the time-reckoning is a more or less arbitrary one, and is dependent on the agriculture. Of the hollows in a block of stone at Batu Sala, in the river-bed of the upper Mahakam, it is said that they originated in the fact that the priestesses of the neighbouring tribes used formerly to sit on the stone every year in order to observe when the sun would set behind a certain peak of the opposite mountain. This date then decided the time for the beginning of the sowing. . . . The Kenyah observe the position of the sun. Their instrument is a straight cylindrical pole of hardwood, fixed vertically in the ground and carefully adjusted with the aid of plumb-lines; the possibility of its sinking deeper into the earth is prevented. The pole is a little longer than the outstretched arms of its maker and stands on a cleared space by the house, surrounded by a strong fence. The observer has further a flat stick on which lengths measured from his body are marked off by notches. The other side has a larger number of notches, of which one marks the greatest length of the midday shadow, the next one its length three days after it has begun to shorten, and so on. The shadow is measured every midday. As it grows shorter after reaching its maximal length the man observes it with special care, and announces to the village that the time for preparing the land is near at hand. In Bali and Java the seasons are determined by the aid of a gnomon of rude construction, having a dial divided into twelve parts.

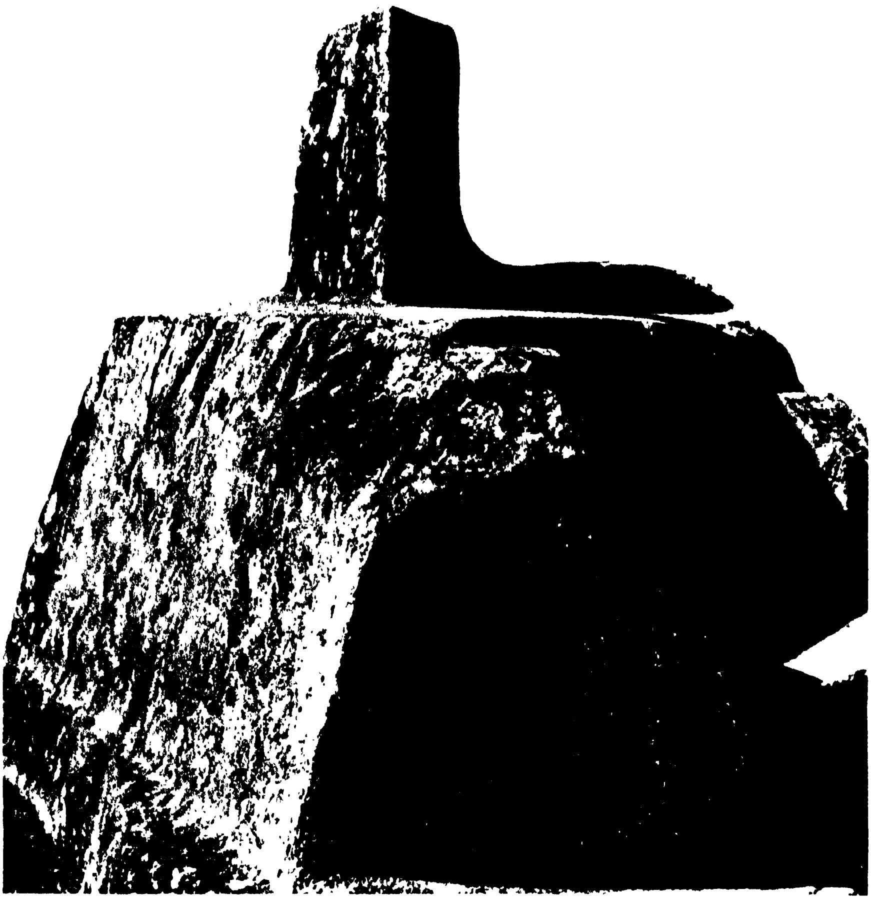
We have also information about what the Incas did in historic times. Again we turn to Nilsson's monograph:

The Incas erected artificial marks. There were in Cuzco sixteen towers, eight to the west and eight to the east, arranged in groups of four. The two middle ones were smaller than the others, and the distance between the towers was eight, ten or twenty feet. The space between the little towers through which the sun passed at sunrise and sunset was the point of the solstices. In order to verify this the Inca chose a favourable spot from which he observed carefully whether the sun rose and set between the little towers to east and west. For the observation of the equinoxes richly ornamented pillars were set up in the open space before the temple of the sun. When the time approached, the shadow of the pillars was carefully observed. The open space was circular, and a line was drawn through its centre from east to west. Long experience had taught them where to look for the equinoctial point, and by the distance of the shadow from this point they judged of the approach of the equinox. When from sunrise to sunset the shadow was to be seen on both sides of the pillar and not at all to the south of it, they took that day as the day of the equinox.

This last account is for Quito, which lies just under the equator. At the spring equinox the maize was reaped and a feast was celebrated, at the autumn equinox the people celebrated one of their four principal feasts. The months were calculated from the winter solstice....

Against this background, it is not difficult to reconstruct the technical problems of the first men who made a calendar which would keep in step with the seasons and to assess what social innovations must needs antedate a solution of them. From temples like Stonehenge and stone avenues leading to burial mounds built by the Megalithic colonisers of Britain and Brittany, we may infer that the first step to a record of celestial occurrences was part map-making, part calendar-dating; and the next step is obvious to most anyone except a state attorney pressing for a conviction. Normal people know that the human memory is a fallible guide to truth—in contradistinction to legal testimony. It is indeed a notable feat of memory to recall a girl born 160 moons ago as overdue for the initiation ceremony which registers her as a woman. To arrive at the conclusion that the solar year is 365¼ days without some mechanical aid to memory would therefore be a superhuman exploit. Just because time flies, you have to make marks of some sort which record the passage of days or at least of moons by cutting some sort of tick on the stones or poles which mark your celestial bearings; and when you have done so, you have taken a decisive step towards the composition of script. You are now becoming a *literate* being.

All this presumes that you are beginning to have a more settled kind of life than that of men in the Old Stone Age. This more settled sort of life, far more than the character of the tools which name it, is what we now mean when we speak of the New Stone Age Culture which begins about ten thousand years ago. It was the consequence of two accidents of human untidiness. One, which is certain, is that dogs hung around the camps of the earliest truly human hunters and food gatherers as the jackal strings along with the hyaena to pick up the scraps from the rich man's table. The other we can surmise with good reason from what we know about nomadic peoples of the present day. If they left grain about in early spring, the tribe would find it sprouting when it returned to



20 *"The Place Where the Sun is Tied" was the name the Incas gave to this huge sun-tower, hewn from a single rock, near Cuzco. In pre-Columban Peru there were elaborate devices for observing the precise arrival of the solstices and equinoxes.*

pitch dwellings on the same spot. This is how man most probably learned to scatter grain, to wait for it to ripen and to store it.

Many thousands of years before settled life began, man had found a friend in his hunting expeditions. The remains of the dog and man go together in very early cave relics; and we find the dog with man wherever neither of them has any title as proper mammals to exist, in Australia where only pouched mammals such as the kangaroo are native and in

New Zealand which lost its link with any big land area before there were any mammals at all. Any cowboy film tells its story of the consequences of this partnership. Put even the most town-bred dog in a field where there are hoofed grazing mammals which live in herds, and he will round them up. If there is a nearby ravine into which man can drive them, the tribe has then a year's supply of meat in cold storage. This did not happen suddenly and dramatically; and it would be strange that man took ten thousand years to become a herdsman in a big way, if we did not realise what a high wall of custom-thought right now comes between human beings and the most beneficial human innovations. Our own generation will risk the possibility of destroying the civilisation of three continents by atomic war rather than get together to do something Alexander Hamilton and Thomas Jefferson have shown us the way to do nearly two centuries ago.

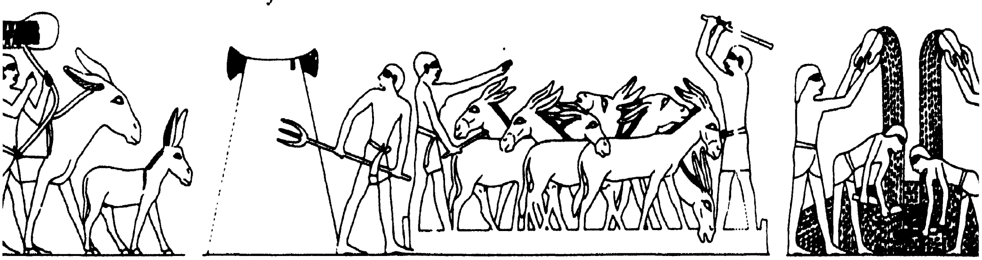
A step so inevitable to a cold-storage economy of settled life is worthy of a digression which dog-lovers will condone. The variety of domestic dogs is without parallel, if we pay regard to the anatomical peculiarities of a Great Dane and a King Charles Spaniel; and such diversity is a challenge to the biologist. Why so many? We do not get near to an answer satisfying to the modern geneticist if we put it in the form: what is the origin of the dog? So stated, the question pays too high a compliment to the science of animal classification. Unlike botanists with the practical exigencies of horticulture to discipline them, zoologists are not very fastidious about what they call a species in contradistinction to a geographical variety; and they have few opportunities for drawing a fine distinction between the two, when they have to classify mammals as museum exhibits. We know that species placed as museum exhibits in different genera of the dog family (*Canidae*) will interbreed freely; and this tells us much. When man comes into the picture, there are very different dogs —jackals and wolves and the like—in different parts of the world, dogs with a very different hereditary make-up but still able to mate with fertile

21 *Dogs helped man towards the settled way of life which at once necessitated and permitted more accurate observation of the heavens. Found wherever man is found, dogs of more than one type, including the greyhound, were common in Ancient Egypt. (Above) Toy of late XIII Dynasty (the rod opens its mouth). (Below) Relief from tomb chapel of Ra'-em-ka, 2481–2453 B.C.*

issue. Given a little more time, and less opportunity, they would be distinct species in the sense that the offspring of a cross between them, if viable, would be infertile like the mule; but the arrival of this inveterate wanderer Man prevents any tidy solution of dog classification. Wherever he goes his dog goes with him and interbreeds with the native dogs. So a stupendous mixing of genes is the outcome. Even in early Egyptian times we have greyhound types; and the first British fossil dog companion of man would pass for a Chow.

It seems a long way from the calendar and from cave painting to the domestic fowl of which there is also a remarkable variety of breeds; but it is relevant because it brings us nearer to the implications of settled life. In blundering into the art of scattering grain, human untidiness provided a sufficient excuse for attaching to the tribe a bird selected with no prevision for laying successive clusters of edible eggs, a bird which followed man in his wanderings, mating with what jungle fowl were locally wild. It would make a good story if we could confidently say that man became a herdsman first, an egg-farmer second, and a harvester third; but we have no clear evidence that this was so. All we know is that some men settled down more or less permanently in one place, some in another, with more than one anchor to curb the frontier tradition. Having done so, they had regularised their seasonal routine and the need for a reliable calendar was more imperative. Having done so, their more settled life gave some of

22 The Land-owning and tribute which grew up with the more settled life of the agricultural communities required records and a script. (Below) Drawings from Egyptian friezes of V and XVIII Dynasties. (Opposite) Babylonian boundary stone of 1100 B.C. inscribed with a deed recording the gift of certain land in Southern Babylonia to Gula-Eresh, by Eanna-Shum-Iddina, governor of the coastal lands of the Persian Gulf.



them more opportunities to record the same celestial events over longer periods. Having done so, more division of work was possible, and occupational groups begin to crystallise, in particular a group of the older persons of the tribe as custodians of the calendar and of the ceremonies appropriate to placating the celestial totems. These old folk have less vested interest in beast-lore. Man is now becoming starry-eyed.

Once you get settled life, and with it a new complexity of occupational specialisation, something else happens. Among hunting and food-gathering folk there is a give and take, a sharing of the spoils. They are nomads and there is little scope for private property among nomads. The settled community life of the Neolithic has to promote a new ideology of proprietorship to make provision for the specialist, in particular the priestly custodians of the calendar and of the ritual which revolves with it. There is land-owning and there is tribute, all of which signifies the beginnings of accountancy. Experts differ about whether the actual task of making a calendar or the accountancy which comes with a privileged caste of calendar-makers has precedence as circumstances which forced on mankind the need for keeping records of enumeration. If the fragmentary remains so far unearthed favour the first alternative, common sense about astronomy, and a lively appreciation of the technical difficulties to be surmounted very slowly before it was possible to amass the calendrical lore of Egypt, Sumer or the Maya culture of Guatemala, favour the other. We are on safe ground if we say that there is a close tie-up between the two. By the time we first find evidence of symbols for enumeration, man has learned to make simple geometric figures to label plots of land appropriated by the priestly astronomers or to chart the lay-out of calendar monuments. He also has somatic symbols of measure, the most primitive units of which persist in everyday life as the *foot* of the foot-rule and the *hand* of the horse-dealer.

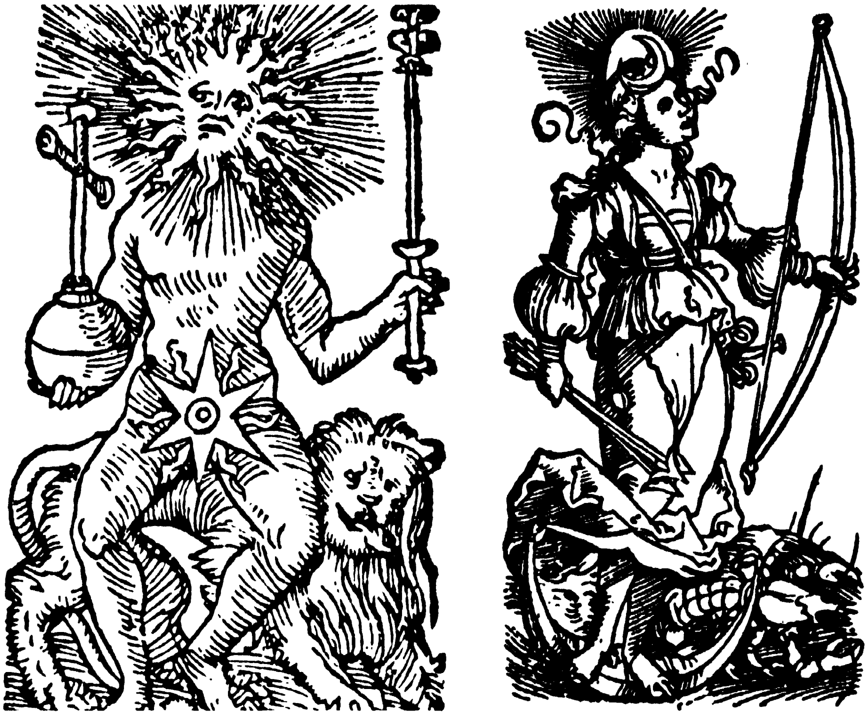
We have thus traced human origins to a stage at which there is a compelling need to record what is too big a job for the memory of the oldest inhabitant; and what is too big is essentially the task of carrying big numbers in the head and of settling a dispute when the arithmetic of the old folk is discordant. Art, technics and social custom now revolve around the calendar; and we cannot read the riddles of the earliest bards with understanding unless we interpret them, as does Robert Graves in *The White Goddess*, against a background of calendar controversy. One great calendar controversy of emergent civilisation arising from the conflicting claims of the sidereal and tropical year suffices to explain the great antiquity of a discovery so sophisticated as the occurrence usually called the *Precession of the Equinoxes*, now attributed to a spinning-top wobble of the earth's axis. The occasion of another was the perennial muddle resulting from the attempt to square sun-timekeeping of either sort with the older practice of moon-timekeeping. No compromise is possible, because the solar year is not an exact number of months; and the confusion resulting from continual revision of a calendar with a 360-day year of twelve 30-day months left an indelible mark on the history of mankind.

Possibly it furnishes an explanation of a change which we can infer with some plausibility from the content of Mediterranean mythology, as suggested by citations from Robert Graves at the end of the last chapter. At the earliest level of the totemistic set-up, when there is as yet no understanding of the essential role the male plays in procreation, human communities commonly reckon descent through the mother. Boy-child or girl-child is an Emu, if the mother's fraternity is Emu, Kangaroo if the mother's is Kangaroo. When history starts, with the great controversy between the sun-time and the moon-time school in full swing, we have abundant evidence of the survival of local cults with women in holy orders and a wealth of legends suggestive of a culture conflict in which the sun-time folk are the pioneers of the patriarchal one-wife family, the moon-time folk, closer to the totemistic tradition, being the conservative party. To say that women were once the dominant sex would be misleading, because modern ideas of dominance imply a high level of occupational specialisation coupled with a special rake-off in a framework of property rights with no parallel at a primitive level of social organisation. Still, there is much to be said for the view that women had a monopoly of the most privileged positions of Mediterranean society ten thousand years ago. If so, it is a pleasant pastime to speculate on why they lost it.

Our close-up of the coming of the calendar has kept in focus the practical necessity of primitive timekeeping and the accompanying totemic ceremonial; but it would be false to leave the impression that man's first dabbling in science was wholly practical from our own viewpoint. The scientific attitude often takes us up the garden path; but what is peculiar to the attitude we call modern science is an eagerness to retrace our footsteps. In the beginnings of astronomy and geometry, Man had to go up many blind alleys, retracing his steps very reluctantly; and one of these blind alleys was unavoidable, because of an exasperating coincidence of Nature's arithmetic with some relevance to the role of woman in the calendar caste. The Latin meaning of the *menses* and the vernacular of our own time alike proclaim the fact that the mean length of the human menstrual cycle tallies closely with the length of the lunar cycle. This is a fact which has puzzled—rather fruitlessly—modern scientists of no mean repute, including Arrhenius; and a British medical journal has published a statistical article on the subject during the last twenty years. That we know from the written record how greatly it impressed the physicians of antiquity should not therefore surprise us.

If, as we may infer from legend, there was some ceremonial tie-up between moon-timekeeping and a function so closely connected with fertility in societies which place so remarkable a valuation on an accomplishment so customary as procreation, we are able to see one reason why the nymphs and the sibyls were on the losing side. Since a moon year of 360 days gets out of step with the seasons far more quickly than the crudest sun calendar based on enumeration of days between two heliacal risings of a star, it is also a far less efficient tool for an economy which relies on forecasting the times of sowing, harvest and lambing. It had to go, and its passing seems to coincide with the ascendancy of a comfortable male rationalisation to compensate the alternate sex for their new role. Women who had exposed their unwanted progeny lightheartedly and had maimed their surplus male offspring as a routine now undertake a new role equipped with an inborn aptitude for child-love.

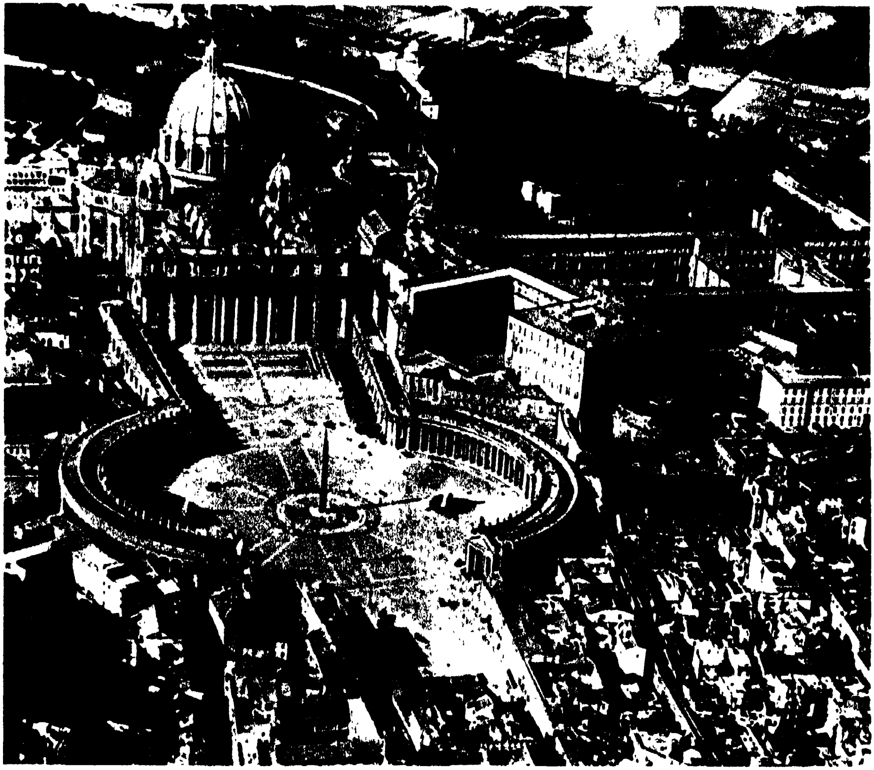
The emergence of the dominant male, and therewith the family as we ourselves understand the term, is still an enigma, and it would be false



23 *Sun and moon long competed for the regulation of the calendar. Matriarchal society, associating the moon-cycle with the rhythms of womanhood, generally favoured moon-timekeeping, and patriarchal society sun-timekeeping. In these sixteenth-century drawings from the "Planetenbuch" the sun is still depicted as male and the moon as female.*

to the scientific attitude to offer a solution without recognising evidence which points to the contrary. Among all the people of the Mediterranean none more reluctantly relinquished lunar time and none more fiercely espoused the cause of the patriarchal family than the Jews, proclaiming the Father-God as supreme, while Greeks and Romans came to terms with the earlier cults by making a niche in their celestial pantheon for Persephone-Proserpine, Athena-Minerva, Hera-Juno, Artemis-Diana, Aphrodite-Venus, daughters of the Great Mother variously known as Isis-Astarte-Cybele-Demeter.

The grove and temple cults of Greek civilisation probably signify survivals of clan ceremonials from an age when each clan had its own



24 *Custody of the calendar was assumed by the Christian fathers, who adapted their own chronology to the beliefs current in Imperial Rome. St. Peter's at Rome is oriented to the true east (where the sun rises at the equinoxes) as carefully as Stonehenge is to the midsummer sunrise.*

ritual year associated with the annual sacrifice of the Totem. In the settled life of a seasonal economy of grain storage and herdsmanship, such private calendar cults are out of place. Gradually, they lose their identity in a more comprehensive system of sun-timekeeping appropriate to a way of life in which there is increasing specialisation. The time has now come for the appearance of a profession of timekeepers who are the first scribes and authors. They are also the first plutocracy, since they derive ample opportunity for levying tribute by virtue of the sacrificial office. What few of us realise is how much of this remains; or why indeed it does so.

In converting the heathen, and in assuming the responsibility for the practical role of the ancient priesthoods as the timekeepers of society when their own cult became the official creed of Imperial Rome, the Christian fathers shrewdly adapted their own chronology to current beliefs. The birth of the Sun of Righteousness must needs now coincide with the beginning of the solar year at the winter solstice; and the annual celebration of the crucifixion symbolised by the sacrifice of the Paschal Lamb must needs happen at the vernal equinox when the sun enters the constellation of the Ram, an occasion consecrated by age-long performance of fertility rites in honour of the Phrygian Cybele and of her consort Attis. By the same token, St. Mary takes her proper place as Isis among the Virgin Mothers of a by-gone age when the nature of paternity was a secret as it is still a secret among the Melanesians studied by Malinowski. In one way, the Church Catholic performed a useful service by preserving the symbolic value of these associations when it sponsored a great reform of the calendar. By prescribing our present system of leap years, Pope Gregory restored the seasonal *status quo* after the lapse of over fifteen centuries since the adoption of the 365¼-day year of the Julian Calendar. Protestant countries long resisted a change initiated for reasons so little relevant to its practical advantages; and there were riots in the streets when a British Act of Parliament set the clock forward eleven days in the middle of the eighteenth century.

FROM CAVE PAINTING TO COMIC STRIP 3

The Arrival of the Alphabet

We have followed the record of human life in early times to a stage when a new synthesis of educational technique lies on the horizon. To appreciate why and where the new synthesis came about we must now familiarise ourselves with a formidable obstacle to world unification and therewith the possibility of exploiting the full benefits of scientific knowledge on a world scale. One of the most tricky contemporary educational problems, so conceived, arises from the immense number of scripts in use and from their various defects. From time to time, enthusiasts remind us that we waste unnecessary school-time, because our spelling is unnecessarily erratic; but any disadvantages we suffer on that account must seem trivial to Eastern peoples among whom writing and reading is still a caste prerogative of a privileged few. It will help us to take the next step in our narrative, if we try to understand their difficulties.

To begin with, it is necessary to recognise that two fundamentally different kinds of writing exist in the world to-day. We shall call one *sign-writing*, the other *sound-writing*. Chinese is the pre-eminent example of the former; the Japanese *Kana*, though like it to the eye and derived from Chinese signs in historic times, is a *sound-script*, as is our own. Chinese writing is a *genre* of much greater antiquity, a Dinosaur in modern dress. We shall therefore be on a more familiar terrain, if we take a look at Japanese first. What Japanese script—or rather scripts—have in common with our own, with the Roman, or with the Russian, and how they differ, gives us a good deal of insight into the evolution of sound-writing, the conditions which have fostered its improvement and circumstances which have impeded its adoption, dramatically emphasising the racialist folly of attributing the major advances of civilisation to the native genius

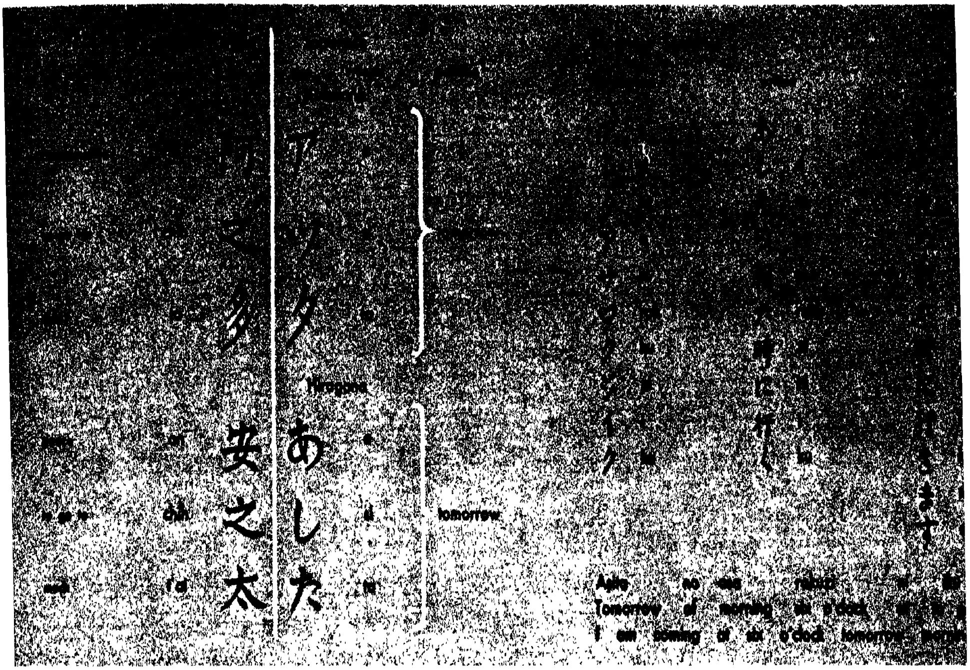
25 In the sign-writing of China, every meaning must in general have a symbol all to itself. Almost inevitably, therefore, the Chinese scholar is a caste apart, writing and reading the prerogative of a privileged few. (A Chinese professional letter-writer at work in Singapore.)

of communities in which they have had their origin.

As the name suggests, sound-writing is the use of signs, more or less consistently, for sounds we utter in speech; but this does not define its more important peculiarity due to the fact that we can classify the sounds we utter in two ways: first, as *words* in virtue of the meaning they convey, secondly as *syllables* or smaller elements (consonants and vowels) in virtue of what we *hear*, regardless of their meaning. In short, a script made up of signs for more or less elementary sound-blocks which go to the making of a single word is a script of which the individual sign has no direct connexion with meaning. The same cluster of signs may indeed stand for quite different meanings, as when we write *die* for the singular of dice, for a stamping tool and to signify the termination of life. Many languages contain such *homophones*, i.e. words with which we can make puns.

The Japanese use two quite different sound-scripts. One is the *Hiragana*, the other the *Katakana*. In telegrams and ads they use the latter, without admixture of current Chinese characters. Otherwise, they use a mixture of Chinese sign-writing and one or other sort of sound-writing. Japanese sound-writing of either kind is in one respect essentially different from ours. Each sign stands for a complete syllable. There is no breakdown into consonants and vowels. On this account, it is convenient to distinguish between two kinds of sound-writing, the *syllabary* and the *alphabet*. The number of syllables into which we can dissect Anglo-American words runs into thousands. So it would be almost a life-work to learn to write our own language explicitly, and to read it easily, if we had to rely on a syllabary such as the Hiragana and Katakana scripts.

Of itself, this is not an educational problem which handicaps Japan, though the muddle arising from current use of two sound-scripts, much less alike than the Russian and the Roman and commonly with a liberal admixture of Chinese characters as the Chinese still use them, is still a headache to progressive Japanese educationists. The fact is that there are less than eighty recognisably different syllables in Japanese words, and it is possible to economise the task of learning the syllabic signs by recourse to a mark comparable to an accent to distinguish syllables which begin with



26 The two Japanese sound-scripts (in which each character denotes a single syllable) are derived in part from the Chinese sign-writing (in which each symbol conveys a meaning directly). The symbols of the Japanese scripts are also shown (right) beginning a sentence, with an expanded spoken form. The translation follows the Hiragana or written version. (Arranged by S. Yanada.)

one or other of the so-called voiceless and voiced members of the couplets *t-d, k-g, s-z.* That it is possible to have a syllabary of about fifty signs, and one which is therefore easy to learn, depends on a characteristic which spoken Japanese shares with many other tongues, for instance the Bantu group in Africa and the Polynesian languages, including Hawaiian. This peculiarity of Japanese and Polynesian languages is easy to understand because we all know place-names such as *Yokohama, Tokyo* and *Kobe, Bali, Honolulu* and *Waikiki.*

In ours, and in any Aryan language, syllables may be simply vowels, consonant-vowel combinations like *at* or *be* in either order, *closed* like *tap* or *pat* with a vowel between two simple consonants or between two

27 *In spite of the simplicity of the sound pattern of spoken Japanese, the wealth of borrowed Chinese signs in written Japanese makes widespread use of the typewriter well-nigh impossible. There are two trays of characters, one beneath the other; a chart of the characters rests near the machine. The knob is brought above the character required (by advancing the roller or moving it or the tray sideways). When the knob is depressed the character is raised and prints.*

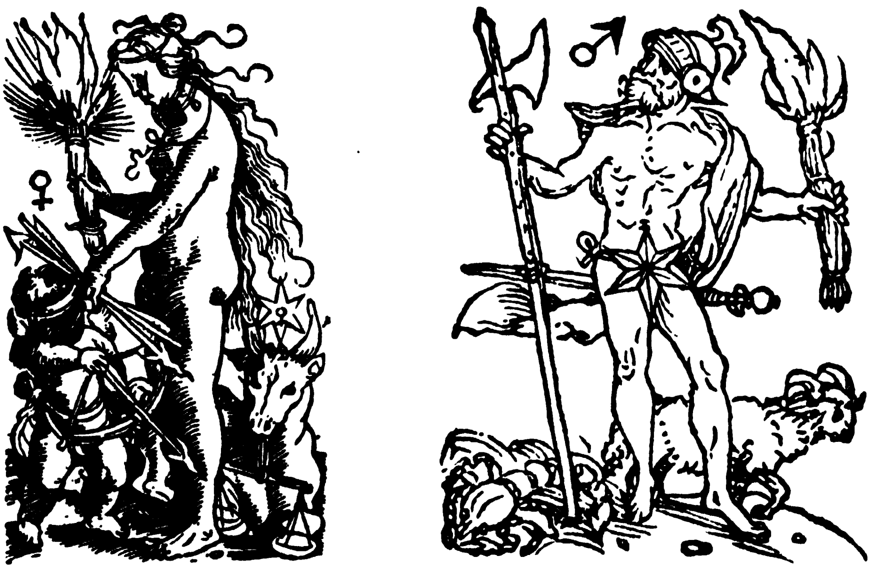
consonant-clusters as in *strand* or *trumps*. From our present point of view, what is interesting about them is that their existence vastly multiplies the number of pronounceable syllables consistent with the sound-pattern of a language. Most speech-communities of the world are unable to tackle such tongue-twisting combinations as we have in *slept* or *striped*; and the reader of Mencken's treatise on the American language will appreciate their difficulties. For Italian immigrants bring with them a speech which has largely lost the essential characteristics of the Aryan sound-pattern. Of itself, the fact that Japanese admits no consonant clusters signifies that it has a much smaller battery of syllables at its disposal; but this is not all. Like Italian it also has a very small battery of pure vowels, and lacks several of our pure consonants such as the two *th* sounds of *worth* and *with*, the common *l* sounds in *lip* and *mill*, the French *j* in *treasure*. What contributes still more to the simplicity of the sound-pattern of the spoken language is that Japanese syllables are either a simple vowel like *o* in *TokyO* and in *KyOto* or a simple consonant followed by a simple vowel like each of the syllables in *Kobe*. The only consonant which can close a syllable is *n*; and the Japanese sound-scripts have a special sign like a French accent to close a syllable with the *n* sound.

If you know this, a little mental arithmetic suffices to show why so economical a syllabary is practicable for the Japanese, and also why Aryan-speaking, or as we shall later see Semitic, peoples could never have solved the problem of universal literacy without taking the additional step which distinguishes alphabetic from syllable writing. Thus far, it therefore seems that the Japanese had a simpler problem than ours to solve. In fact, this is not so; but we can best appreciate why a Japanese typewriter (*tuparaita*) needs a dining table to support it, if we now switch our attention to the parent culture of China where the official script has no relation to sound at all.

To understand what is most characteristic of Chinese writing would be more difficult, if our own script were one hundred per cent sound-writing as defined above. In fact, Americans and Europeans of all nations do use such symbols as 5 for exactly the same meaning, though represented as a sound by *fem* in Swedish, in French by *cinq* and in German by *fünf*. We use & for the same meaning which we represent as *et* in French, *und* in German, *og* in Danish. All over the world astronomers recognise ♂ as Mars, ♀ as Venus. In all countries where there is modern medical education, a physician recognises ♂ as male (*pl.* ♂♂), ♀ as female (*pl.* ♀♀). In fact biologists most everywhere would be able to read the expression 3 ♂♂ & 2 ♀♀. In principle, that is the way the Chinese write. It has one great advantage which the foregoing examples make clear. For it is the one common language of all China. People in different parts of China speak languages which are of the same parentage, as are most of the languages of Europe which is smaller than China; but the speech of people in Canton is as unintelligible to the people of Peiping as is Portuguese to nearly all Norwegians. In spite of this they can all understand the same statement in writing, if they read at all; and if they read fluently, they can all read the same classics.

The great disadvantage of the system is that every meaning, whether represented by words we pronounce like *die* in the same way, or by words we pronounce uniquely, has to have a symbol all to itself. Modern textbooks of human anatomy are said to contain about 5,000 different technical terms. The American medical student would therefore have to learn thousands of signs, if Americans used the sort of writing current

28 *The western world makes use of sign-writing. Astronomers everywhere use the same symbols for Mars and Venus; physicians use them also to denote male and female. Both meanings were apparent already in these drawings from the sixteenth-century Planetenbuch.*



in China. Almost inevitably therefore the Chinese scholar, even the scholar in the traditional sense with no pretensions to knowledge of modern technics, is a caste apart. Unhappily, there is little to encourage the hope that China will make its full contribution to the common life of mankind till it can take its place on equal terms among nations which regard literacy as a prerequisite to good citizenship; and it is not likely that China will implement a programme of universal literacy until it adopts a different technique of writing.

The civilisation of China has an unbroken record of peculiar duration, and we can trace the steps by which the several thousand *characters* in common use had their origin in pictures of sorts; but we have to be clear about what we can picture before we can understand how this older sort of writing began. We can picture some things because they are picturable; and we have now seen how pictures can become signatures of time units. You (the reader) are a Crab man or a Crab woman. The Crab sign stands for the Crab, also for your surname, and for the month (at present May) which marks the beginning of the Crab-clan year. If you are a sibyl or a medicine-man who has to prescribe when the ceremonies of the Crab year are due to happen, you will have learned to chip marks on stick or stone because the human memory is fallible; and the first three Roman numerals I, II, III—like those of the Egyptians or Chinese—leave us in no doubt about how you tackled your assignment. When you have done so, you have now the main ingredients of the sort of writing the great indigenous American civilisations achieved—heraldic symbols (calendrical hieroglyphs) for what time-units you are recording and number-signs to enumerate them without relying on your very fallible memory. This is the main preoccupation of the priestly writings of the Maya civilisations whose stone remains have come to light in Guatemala.

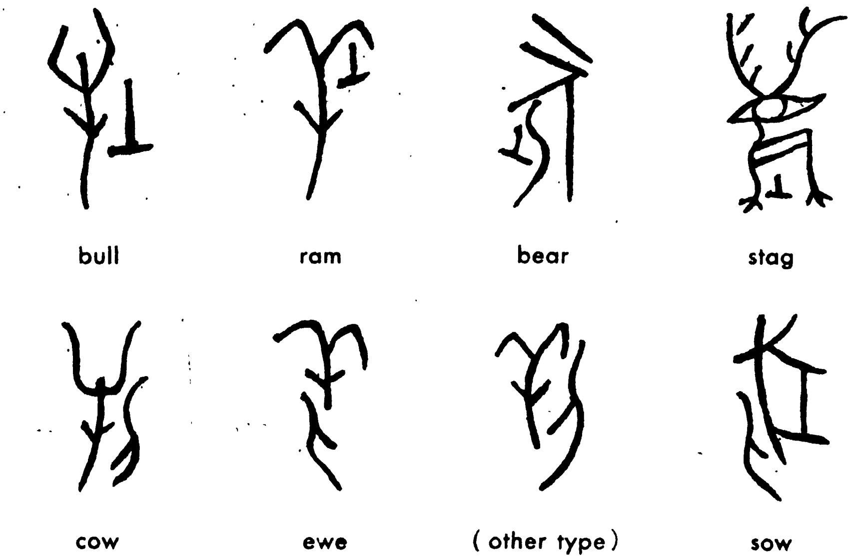
In reconstructing the broad outlines of the story, we need not retrace our steps beyond a stage which signalises the indispensable minimum solution of the requirements of a caste of calendar specialists who live by telling us when the time has come to sow the corn and to sacrifice to the corn-goddess. Let us imaginatively picture how we might represent four goat years, i.e. years beginning when the sun enters Capricorn, by using both our number marks of Chapter II and our totemic signatures of Chapter I:

It is not a big step to amplify our Isotype dictionary, if we want to record an event which happens four new moons before the sun enters Capricorn or four new moons after:

When we have got so far, we are very near to sentence construction, and the earliest form of Chinese writing brings into the picture a trick which is not really new. We have learned to use the goat sign for the animal, for our horizon bearing in our trek to hunt or to sacrifice it, and for the time of the year when it is abundant; but if we want to distinguish cow from bull, cock from hen, dog from bitch, ram from ewe and so forth, we must either double our battery of signatures or resort to a new device. One such device is to combine the human male sign—which scarcely needs explanation—with the human female sign to distinguish a nanny goat from a billy goat thus:

Fig. 29 shows that this is exactly what the Shang period Chinese had learned to do 4,000 years ago. By that time, the pictorial origin of the symbols is already blurred; but we can see enough to pay our respects to a new achievement. If we had to use a separate picture symbol for ram and ewe, bull and cow, man and woman, cock and hen, our dictionary of Isotype would have to be much bigger. By making a symbol for maleness from a picture we associate with what is characteristically male and a symbol for femaleness from a picture for what is characteristically female, we can reduce the load of animal characters we have to carry by fifty per cent. Commonly, the written Chinese word has to-day two such components. For example, the sign for the sun followed by the sign for the moon means *bright* or *brightness*. Sometimes, however, one component which qualifies or amplifies the more meaningful one called the *classifier* is any word with the same sound as the word which the compound character itself signifies, as if we were to use the sign ♂ followed by the picture of a *buoy* for a male child.

All the earliest writing of the world, that of Egypt, of Crete and of Mesopotamia, when writing began about 5,000 years ago, was essentially picture-writing in this sense, though the original significance of the pictures



29 In this Chinese picture-writing of the Shang period (second millennium B.C.) the use of standard symbols for male and female begins to reduce the number of separate signs necessary. Note the change of position to differentiate between two types of ewe.

is soon difficult to trace for a reason which is simple enough. Few of us write like the copy books. Our paper style of writing is different from our blackboard style and the fountain pen or the pencil we use affects our style—as Damon Runyon would say—more than somewhat. Every scribe of the Egyptian and Mesopotamian priesthoods which put writing on the map of the Western world would have a line partly of his own, partly dictated by the marker instrument (style, pen, punch or brush) he used and partly by the material (stone, clay, wax, papyrus) on which he made the record. Characteristic features of ancient scripts—sign-writing and sound-writing alike—are traceable to these two circumstances.

From the level fossilised in the Mayan culture, priestly sign-writers proceeded, and elsewhere at a much earlier date, to conventionalise, to

elaborate and to classify a battery of characters suitable for recording auspicious events as well as for the discharge of their original function, the accountancy of the ceremonial calendar and the book-keeping of its costly custodians who exacted lavish tribute of land and animal produce for the sacrificial rites. The elaborations were often whimsical and included visual puns, as if we were to represent the word *belief* by putting the picture of a *bee* beside the picture of a *leaf*. In Egyptian sign-writing, in Sumerian and in Chinese this sort of thing may happen; but it is of doubtful relevance to the origin of any consistent system of sound-writing.

Except in Mesopotamia, where the process last mentioned may have gone further by its own momentum, sound-writing emerges, when it does emerge, suddenly and in circumstances attendant to culture-contact between literate sign-writing people, such as the Chinese or Egyptians, and non-literate people, such as the Japanese or Semites, imperfectly able to communicate with their schoolmasters by speech. This coincidence gives us a suggestive clue to the way in which sound-writing starts. If you do not understand the meaning of the sound your instructor utters when he or you point to a character, what is a symbol of meaning to him can be only a symbol of sound to you. To drive this point home, Bodmer's book *The Loom of Language* cites a parable, with no pretence that it is more. We will imagine that the English army at Agincourt had used a sign-writing which represented a cock and a lord by the characters: 
A Frenchman, unfamiliar with their language, would elicit by gesture from his invaders a response suggesting that the combination signified a *coquelourde*—in his tongue the name of a flowering plant. To him, therefore, it might seem to be the Englishman's way of labelling a wild anemone. Any fruitful outcome of culture-contact in such circumstances presupposes certain conditions which have nothing to do with the native ingenuity of the folk who take a step with such momentous results. If they are already trading folk alert to the inconvenience of book-keeping at a preliterate level, they will have no scholarly prejudices to conserve the mysteries of a priestly script by mystifying elaborations. Their bias

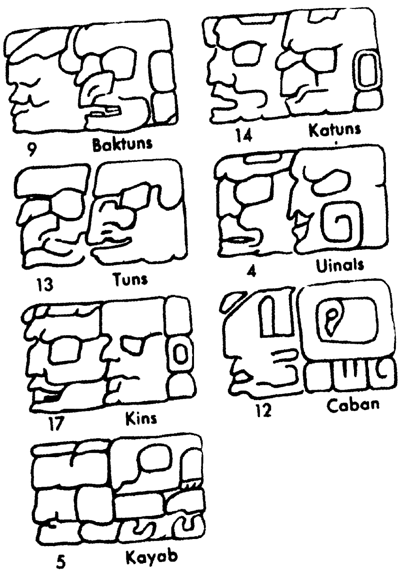
30 *The original significance of the primitive picture is soon difficult to trace. The nature of the writing instrument and materials and the growth of conventions change the signs, as these five Chinese signs have changed over more than 3,000 years. (Drawn by Professor Cheng An-chih.)*

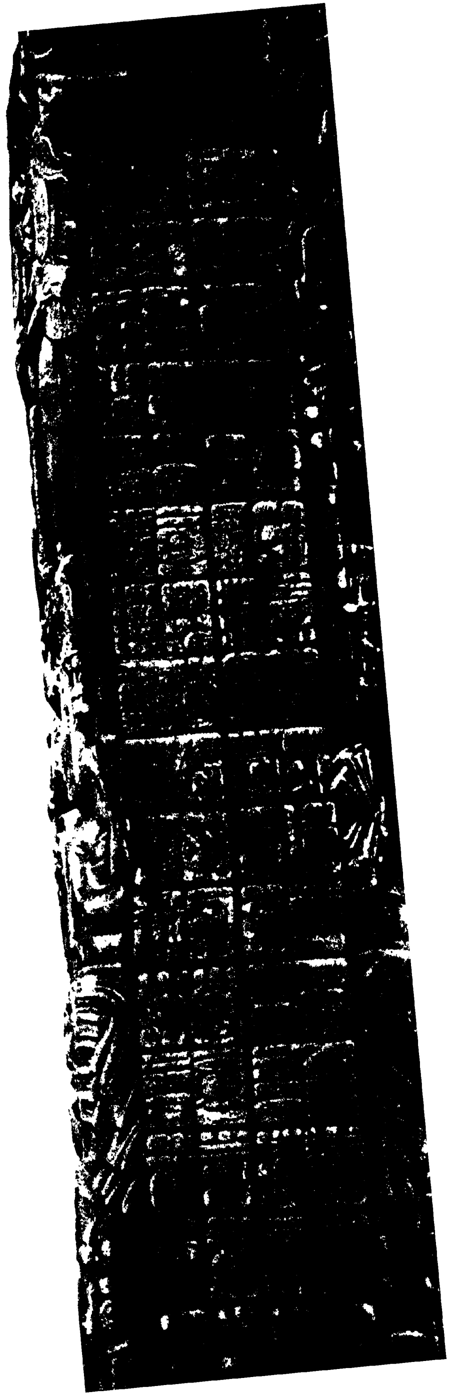
will be towards economy and simplification. It is therefore relevant that the invention of alphabetic writing took place in the great melting-pot of Mediterranean barter.

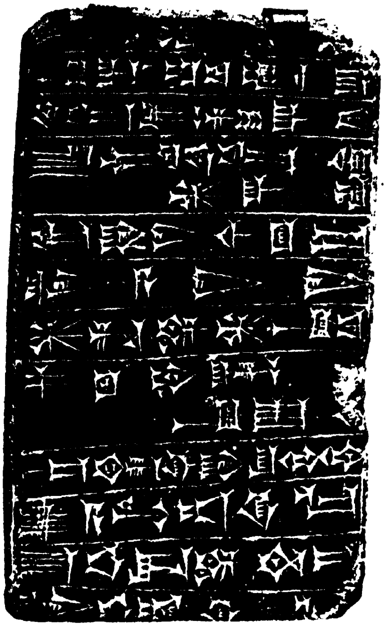
Even so, it is necessary to take stock of another circumstance which the known origin of the Japanese syllabaries brings sharply into focus. We have seen that a simple syllabary for Japanese speech is possible because Japanese speech has a sound-pattern different from ours, and that the Japanese have two quite different syllabaries (the Katakana and the Hiragana), each of the signs of which is traceable to a Chinese character for a Chinese word with a particular meaning quite unrelated to the sound-value of the syllable in spoken Japanese. The switch-over portends something about the structure of Chinese speech, which is in fact almost exclusively made up of *one-syllable words* of the same type as the individual syllables of the Japanese polysyllable. In the Peking speech closed syllables other than those which end with *n* or *ng* as in *Yang-tse Kiang* do not occur at all, and Canton speech admits in addition only syllables closed by *k* as in *Chiang Kai-shek* and by *t* or *m*. It goes without saying that the number of Chinese words individually distinguishable to the ear is remarkably small, and that it is possible to work with so small a battery of sounds consistent with the language-pattern only by exploiting to the full every possible combination of consonants and vowels the Chinese use. Differences of tone help to distinguish meanings like *boy-buoy* or *son-sun* associated with the same sound; but the same sound in the same tone has often many meanings. The structure of Chinese speech thus ensures that there is in fact at least one word with the same sound for every syllable in Japanese, and often the choice of several. Since the character for a Chinese word labels its meaning, there are characters to spare for the make-up of more than one syllabary.

If this peculiar local accident of language-structure betokens no native genius for the invention of writing, it is equally true that the present muddle which handicaps Japanese self-education betokens no special lack of aptitude for improvisation. As Anglo-American has absorbed from

31 *The priestly picture-writings of the Maya civilisations consisted of a number-sign (left head) and a calendrical hieroglyph which denotes the time unit (right head). The drawing is of the first seven pairs on the calendar stone, which is of the great period of the Old Mayan Empire, found at Quiriguá, Guatemala. In the translations 1 Kin=1day, 1 Uinal 20 days, 1 Tun 360 days, 1 Katun 7,200 days, 1 Baktun 144,000 days. Kayab is the name of a month, Caban the name of a day.*


9 Baktuns
14 Katuns
13 Tuns
4 Uinals
17 Kins
12 Caban
5 Kayab





32 *All the earliest writing of the world was essentially picture-writing, but it was conventionalised and classified by the time written history begins. By 3000 B.C. the Mesopotamian incised writing had reached the form shown in the plaque from Nippur (top left), a thousand years later the cuneiform of the inscription in the name of Rim-Sin, king of Babylon (above). About 2950 B.C. a wooden panel from a grave near Sakkara, Egypt (right) shows hieroglyphs in which few of the symbols retain their direct picture-meaning and the Papyrus of Pedin-Imenet (left) shows also the hieratic script.*

33 *Sound-writing by syllables, as in modern Japanese, originated several times. The ancient Cyprus code came into use about six centuries B.C. The signs, shown above, are for open syllables of the vowels alone or combined with the consonant sound, as ka, ke, ki, ko, ku. The bronze club (drawn from one found at Dali) and the Bronze-Age clay ball (found at Enkomi) both show Cypriotic engraving. No multi-lingual key has been found, and the language is not known.*

its classical schoolmasters an enormous number of words of Latin origin within the framework of what was originally a Teutonic tongue, Japanese has absorbed an enormous vocabulary from the Chinese classics and from trade with the mainland. Consequently, it staggers under a monstrous burden of pun-words. Even in speech, where context supplies so much, the Chinese themselves have to resort to repetitions and couplets to sidestep misunderstanding, as if we were to say *boy-son, buoy-beacon* or *son-child, sun-star*; and the coolie carries this trick over into pidgin English. Now no such confusion arises in the written language, because the same sound has as many characters as meanings; and the incorporation of many Chinese characters for roots, i.e. for the meaningful part of the

word like *love* in *loveliness*, therefore guarantees that Japanese, as usually written, is explicit at the expense of economy.

How they can extricate themselves from the penalty of their pun-words is a major social problem common to China and Japan. It adds an enormous burden to the education of those to whom it is available, makes widespread use of the typewriter well-nigh impracticable, and immensely complicates the problem of bringing the written word to millions of citizens of a country which contributed silk, gunpowder, paper, and block printing to our common civilisation. Happily, the problem is not insoluble, and progressive educationists of both countries are trying hard to solve it. The trick by which we distinguish *boy* from *buoy* suggests one of several possible solutions.

Sound-writing by syllables alone has originated several times. A notable but short-lived example is the Cyprus code which came into use about six centuries before the Christian era, when the island was a great metallurgical centre of the Mediterranean world. It consisted of about 55 symbols, five being for pure vowels; and its make-up is otherwise comparable to the Katakana with much the same range. Unfortunately, we do not know the ancient language of Cyprus, and cannot say with certainty whether it was fitted to its original role. What we do know is that the attempt to use it as a medium for Greek, before the Greek-speaking colonists of the Mediterranean took up the alphabet in a big way, was a lamentable failure. Greek, as we all know, is an Aryan language, and the words *apostrophe* or *anthropology* remind us that Greek as such is rich in consonant clusters and closed syllables.

It is easy to understand the difficulty of adapting the Cypriot syllabary to Greek use, if we try to represent our own word *strength* as a sequence of open syllables, i.e. *se-te-re-ne-ge-the*. To get far with a language such as Greek, it is thus necessary to use signs for units of sound smaller than a syllable, in short to have a true alphabet of consonants and vowels. The assembly of such a battery of signs for elementary sounds has happened once only in the history of the world. If we exclude imitation alphabets, such as the Ogham script on Celtic stone monuments, it is true to say that the alphabets of India, Arabia and of the Moslem world in general, that of Hebrew, that of Greek, the Roman, the Russian and the Runic of Scandinavian inscriptions are alike descendants of a single parent. This is not so surprising, when we consider the immense difficulties which beset the task.

Though it is possible to trace the ancestry of all true alphabets to a common parent, the present similarities between any two may be quite unrecognisable. Divergence began at a very early date, when the use of alphabetic writing was confined to very modest uses, short inscriptions with little regard to the orientation of individual signs and no fixed convention of horizontal or vertical sequence. Some scribes wrote from right to left, others as we do. Some alternated, and others wrote the signs in columns rather than rows. As different conventions of sequence crystallise out, individual signs take on an orientation dictated by whether one writes from left to right and vice versa or from top to bottom and vice versa. Inevitably also, the aspect of the signs undergoes changes dictated, like successive styles of Chinese writing, by the writing tool and by the writing surface.

The exact origin of the symbols we do not know. Similarities to Egyptian picture-symbols, to the undeciphered priestly sign-writing of ancient Crete, to cuneiform scripts of Mesopotamia at different stages in their chequered career of foreign conquest from pure sign-writing to syllabary, to the Cypriotic and to a very ancient syllabary of Byblos in Syria have all had learned and sometimes impassioned advocates. Dr. David Diringer's recent presentation of all the evidence seems to show that an alphabet was already in use about 1500 B.C., and there is general agreement that the first people to use it were Semitic peoples. The essentially new step was the association of a bare *consonantal* element, instead of a whole syllable, with whatever character the first alphabet-makers took into their battery of signs in that capacity. The signs themselves may possibly have come from more than one source. If so, more than one theory of their origin may have something to commend it.

To understand why it was possible, and only once possible, to take this step, we surely need to ask ourselves whether those who first took it spoke a language in which the consonant plays a peculiar role; and this is pre-eminently true of the Semitic tongues. In his book *The Loom of Language*, Bodmer gives examples to show how easy it is to read a sentence if we replace the vowels by dots, but how well-nigh impossible if we replace the consonants by dots. He goes on to say:

> Owing to the build-up of Semitic root-words, we have no need of dots to give us this information. Once we know the consonants, we hold the key to their meaning. Any syllabary based on twenty-odd open monosyllables with a different consonant would therefore meet all the needs of a script capable of representing the typical root-words of a Semitic Language. . . . One peculiarity of the Semitic languages gives us a clue to the unique circumstances which made possible this immense simplification. Semitic root-words nearly always have the form which such proper names as Jacob, Rachel, David, Moloch, Balak or Balaam recall. They are made up of three consonants separated by two intervening vowels, and the three consonants in a particular order are characteristic of a particular root. This means that if cordite were a Hebrew word, all possible combinations which we can make by putting different vowels between k and d or d and t would have something to do with the explosive denoted by the usual spelling. This unique regularity of word-pattern led the old Rabbinical scholars to speak of the consonants as the body and the vowel as the soul of the word.

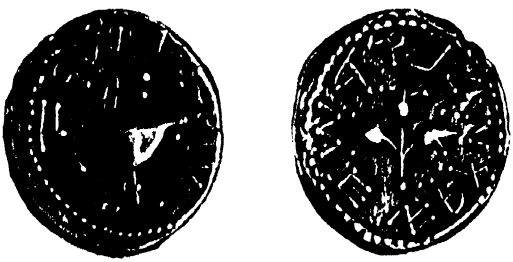
Dr. Diringer himself affects the loyalty of the scholar to his own kind when he tells us that only the Syrio-Palestinian Semites produced a genius who created the alphabetic writing; but the student of human affairs may prefer to think that he gets to closer grips with the problem in the following statement which is substantially in agreement with that of Bodmer cited above:

> The alphabet was created for Semitic languages and is sufficiently suited to them. This is also proved by the fact that even nowadays neither the Hebrew nor the Arabic languages use the vocalic punctuation except in a few justifiable cases. In fact, the Semitic languages are based chiefly on roots, which give us the fundamental conception . . . while the vowel sounds give us only the complements, the details such as the part of speech, the voice, the mood, the tense.

The so-called Roman alphabet we use to-day is not wholly of Roman origin. Two letters (*K* and *Y*) come from the Greek which is the basic substratum of the Russian (Kyrillic) script and its unliquidated link with the Byzantine Church. Ours is by no means perfectly adapted to the needs of a fundamentally Teutonic language, having no symbols for the two different pure consonants we represent by *th*, for the pure consonant represented by *ng* in si*ng* or for two other pure consonants elsewhere mentioned. It has a quite inadequate equipment of vowel symbols without recourse to conventional combinations, one sign (*J*) usually employed for what is not a simple consonant, and three redundant signs (Q, *C* and *X*). We surmount some of our difficulties more or less successfully by arbitrary combinations like *sh* in words of Teutonic origin, though we retain the Latin spelling for the same way of pronouncing *ti* in words of Latin origin; but the representation of Anglo-American vowel sounds by recourse to the battery of five pure vowel-symbols good enough for Roman speech is chaotic, and it would be difficult to formulate acceptable standard conventions for our own range of vowels, because the vowel is the trade-mark of local dialect.

Here we may turn again to Bodmer's book:

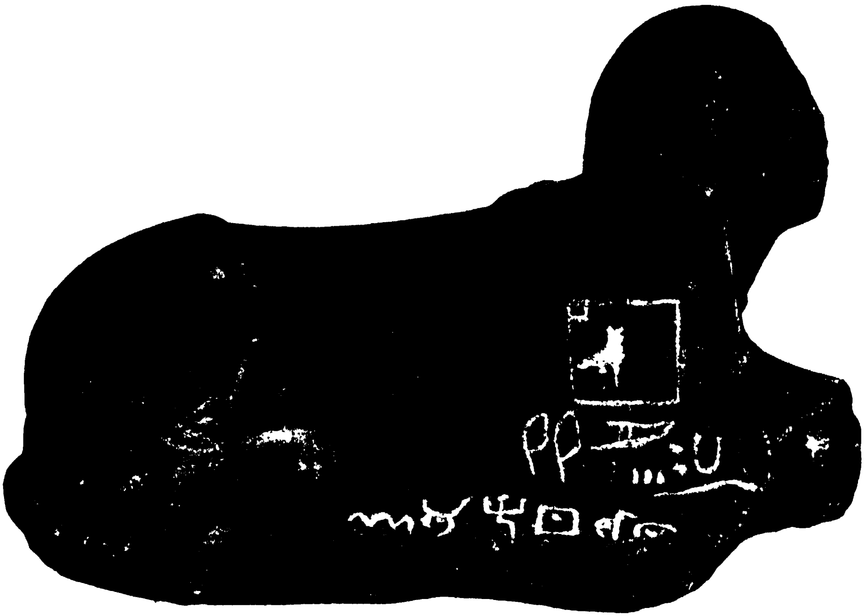
> Even when two languages which share the same alphabet enjoy the benefit of a comparatively regular system of spelling as do Norwegian, German, and Spanish, many of the symbols have different values when we pass from one to another. So spelling is never a reliable guide to pronunciation of a foreign language. For this reason linguists have devised a reformed alphabet for use as a key to help us to pronounce words of any language

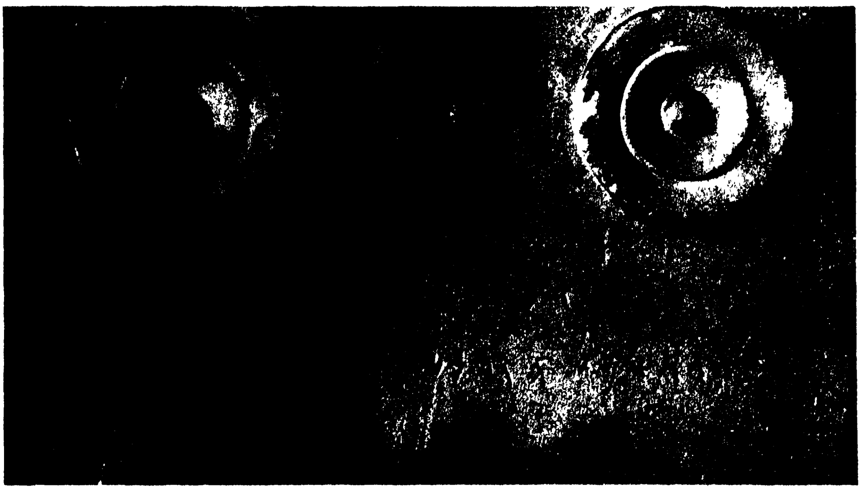


34 *The Semitic tongues were the uniquely suitable soil from which an alphabet could grow. A language was required of which the consonant sounds were the roots and the vowels only the complements. On this Hebrew coin of 66–7 A.D., the inscriptions read, counterclockwise, Shḳl Yśr'l (the Shekel of Israel) left, and Yrwshlm Kdshh (Jerusalem the Holy).*

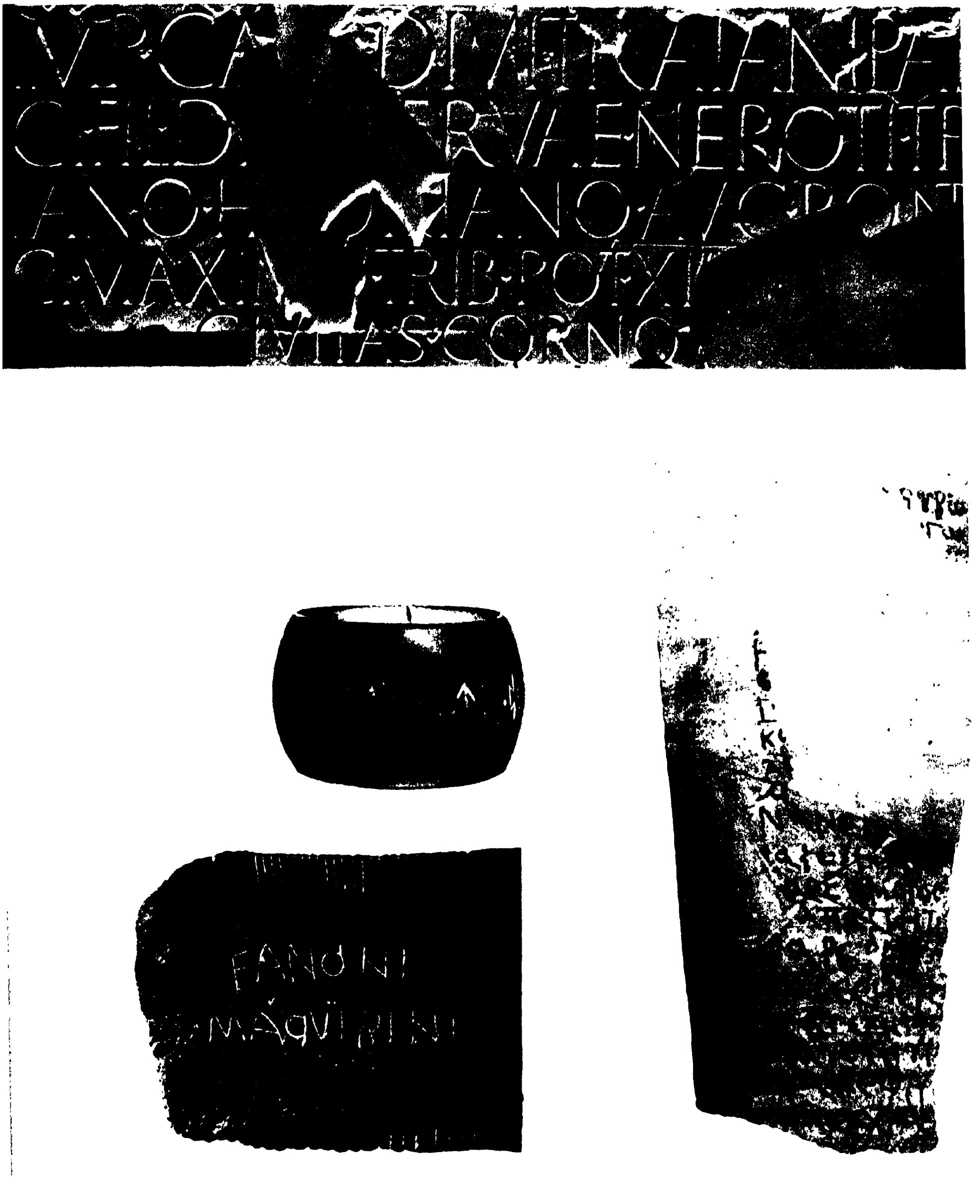
with at least sufficient accuracy to make intelligible communication possible without recourse to personal instruction.

The international script employs sixteen Roman consonant symbols with their characteristic signification, *viz.*: *b, d, f, g, h, k, l, m, n, p, r, s, t, v, w, z*. For the *th* in *th*ick it employs the Greek *θ*, and for the *th* in *th*en the Icelandic *ð*. The *sh* and *ng* (in si*ng*) sound symbols are respectively ʃ and ŋ. For the French *j* sound in vi*s*ion or trea*s*ure it uses the Erse ʒ. Thus *ch* in *ch*at is *t*ʃ and our *j* in *j*am is *d*ʒ. The symbol *j* itself has the German J sound-value like *y* in *y*et. A glance at *The Gospel in Many Tongues* published by the British and Foreign Bible Society (1939) shows that the efforts of experts on phonetics have not been fruitless. This brochure exhibits specimens of the Scriptures in 734 languages, for about half of which devoted missionaries have created a script with little or no assistance from colonial governments and often in the teeth of active hostility of the white trader and the concession hunter. The more recently created scripts for the use of preliterate peoples on whom missionaries have bestowed the benefits of the printed word take ample advantage of the new consonant and vowel symbols to compensate for the inadequacies of an alphabet *en rapport* with the speech-habits of the Italian peninsula in the time of Julius Caesar. Thus we recognise them in excerpts of the Bible translated in *Bari* (South of Anglo-Egyptian Sudan), *Ebrie* (Ivory





35 *All true alphabets are the descendants of the single parent which sprang from the Semitic tongues. The sandstone sphinx from Sarabit al-Khadim carries a Sinaitic inscription of between 1800 and 1200 B.C.—one of the earliest known alphabetic inscriptions; the tombstone of Artemidoros (Athens, 4th century B.C.) has the name in Phoenician.*



The potsherd (bottom right) is later Greek, found in Egypt; above is a cast of the dedication tablet of the Forum, Wroxeter (A.D. 129–130), carved in Latin; the gravestone (A.D. 500) is inscribed with the names of Celtic persons in Roman and Ogham scripts. In the latter strokes stand for alphabetic characters. The agate ring carries a Runic inscription of 9th–11th century.

Coast), *Eggon* (Nassarawa province of Nigeria), *Ewe* or *Efe* (S. Togo-land), *Kate* (Papua), *Mende* (S. E. Sierra Leone), *Mundang* (Upper Benue R., Fr. Equat. Africa), *Nuer* (A. E. Sudan), *Ogoni* (Opoto, S. Nigeria), *Teso* (E. Province, Uganda Protectorate), *Xosa* or *Kafir* (Kaffraria, S. Africa).

Here are two examples:

(a) *Dagbane* (N. Gold Coast)
A kul ni dʒɛm la a-Duuma Naawuni, kulla o kɔ ka a ni dʒɛm.

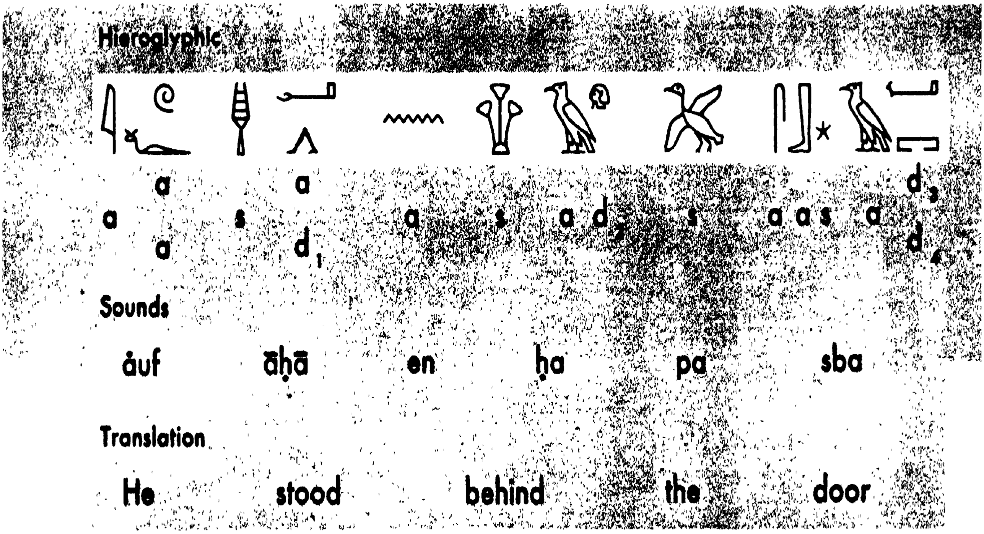
(Matthew, iv, 10)

(b) *Dyerma* (French W. Africa)
Zama Irikwei kamna ndounya, hal a na inga Izo no, inga 'foloŋ hayante, zama boro koulou kaŋ go kchimin'a· ʃe; a ma ʃi hasara, amma a ma dou foundi hal abada.

(John, iii, 16)

For reasons already stated, many of the true alphabets of the East have become exceedingly cumbersome in the course of their evolution; and the need for extensive reform of the alphabet as a prelude to educational advance is not one which concerns China and Japan alone. What advantages we ourselves do enjoy from an alphabet comparatively easy to master in early childhood are our culture-debt to the Semitic peoples of Mediterranean antiquity. The awakening of the East may be the signal for benefit to ourselves from reforms we are too lazy to undertake on our own behalf.

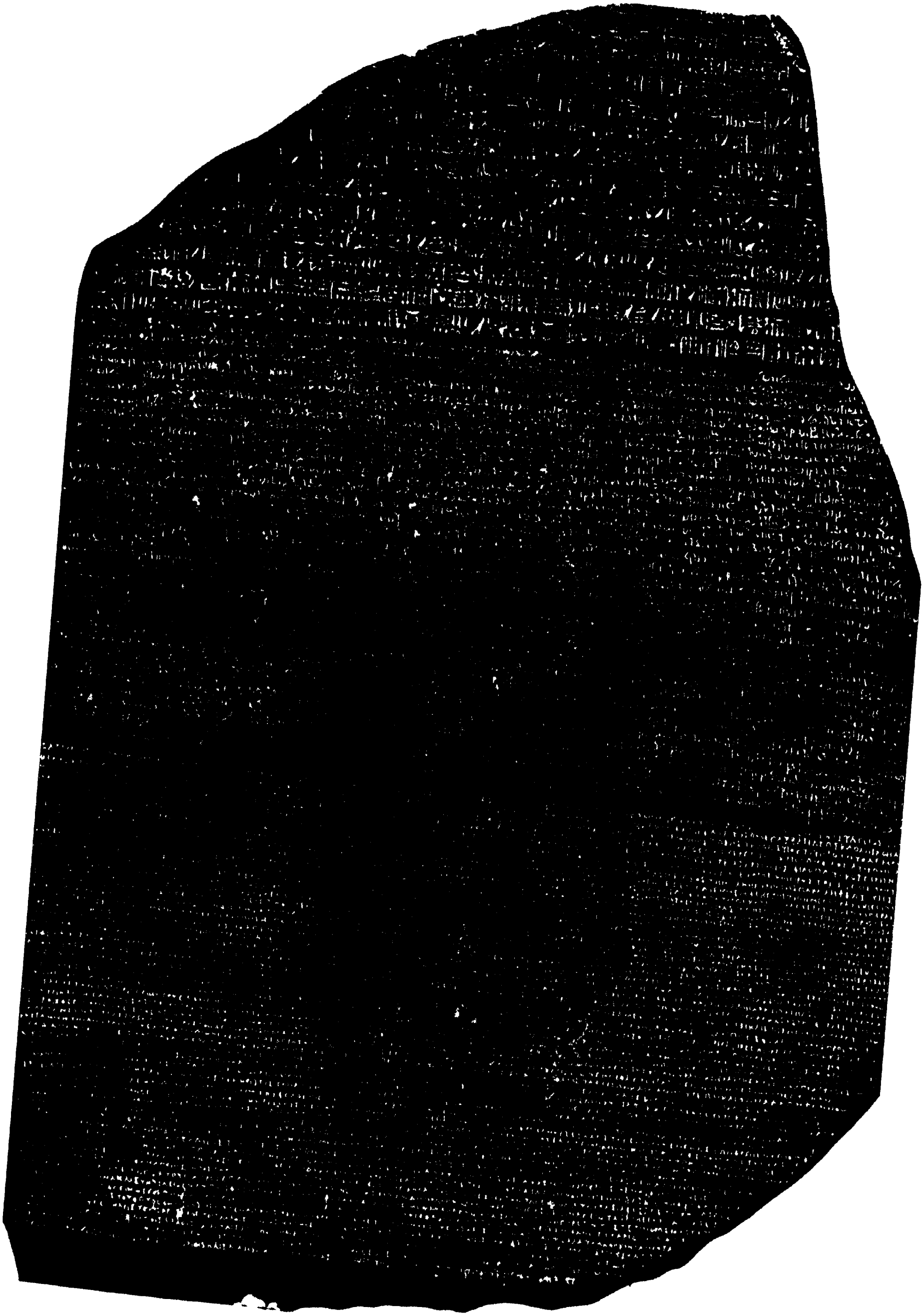
In the Western world of antiquity, there were very many different systems of sign-writing in vogue, from the three earliest of which, those of Egypt, Mesopotamia and Crete, we have now a wealth of remains exhibiting a long history of elaboration from simple pictorial characters to writing at first sight almost like alphabetic script. Happily, monuments and documents displaying the same epitaph or record in more than one language and in more than one script have made it possible during the past hundred years for scholars to master the secrets of Egyptian and Meso-potamian civilisation. Until the nineteenth century there was a mythology about the learning of the Egyptians unjustified by a single useful clue to the

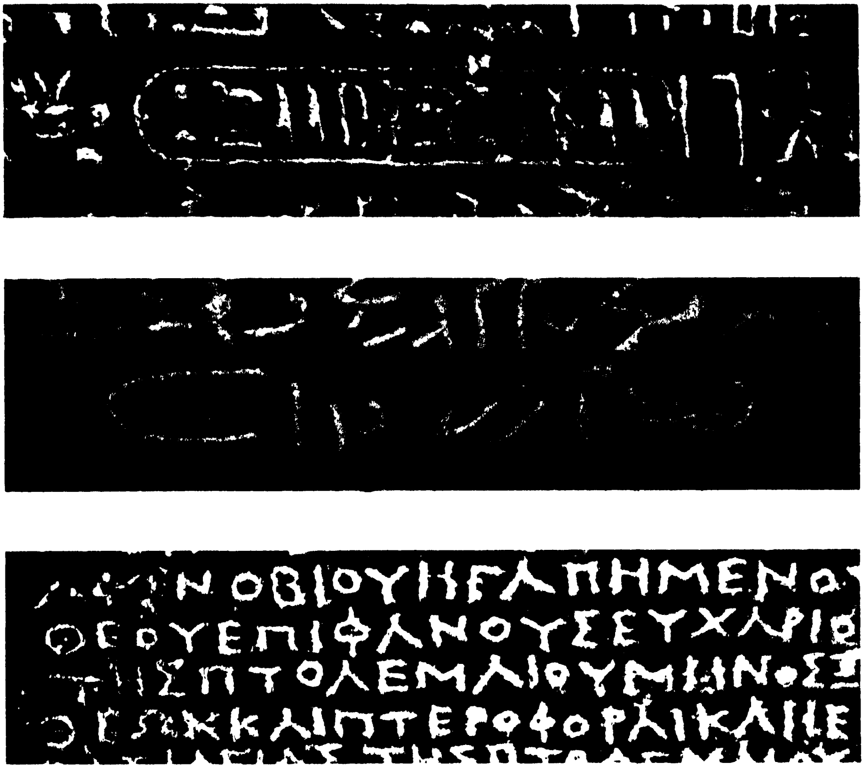


36 *During the past hundred years, scholars have mastered the secrets of many of the ancient scripts. This constructed sentence illustrates the complex structure of Egyptian hieroglyphics. The symbols a, a, a . . . are alphabetic characters, s, s . . . are syllabic characters and d, d . . . are determinants which still show traces of a direct pictorial meaning. Thus d1 (legs) denotes "walk, stand", d2 (profile) "behind", d3 "wood", d4 "house".*

meaning of their written language. During the French invasion of Egypt in 1799, one of Napoleon's entourage noticed an old stone in a wall at Rosetta on one of the tributaries of the Nile. This now famous find had three sorts of writing on it, straightforward Greek, the familiar picture writing of the tombs and its later cursive derivative called *demotic*, at that time unknown.

The Greek part disclosed that it was about a king called Ptolemaios —one of the dynasty of generals left behind in the wake of the conquest of Alexander the Great. The date of the writing is 196 B.C. and the last line says that a copy of the writing is to be made on hard stone in the old writing of the country and in Greek itself. Evidently therefore we have here three translations of the same story; and fortunately, many of the words in the Rosetta story repeat themselves. Eventually, scholars were therefore able to decipher a fairly long piece of priestly—





37 *The Rosetta Stone, carrying the same text in hieroglyphic, its cursive derivative demotic, and Greek, was the key which unlocked the secrets of the civilisation of Ancient Egypt. The three enlargements above, photographed from the stone itself, show the same word: Ptolemaios. In the hieroglyphic, which runs backwards, it is the second half of the encircled section.*

and demotic—writing word by word. From this start, systematic comparison of inscriptions led to what is now a scientific understanding of the written record of Egypt.

The reader who wishes to get a close-up view of how the scholar fumbles his way to the reconstruction of a language hitherto undeciphered by taking advantage of bilingual (or trilingual) inscriptions such as the Rosetta Stone, may with profit try out the following exercise in Urdu from a British (*Northumberland No. 1*) intelligence test designed by Pro-fessor Godfrey Thomson:

The sentences below are in a foreign language, and their meanings are given in English. In each English sentence a word is underlined, and you have to underline the word which corresponds to it in the foreign sentence. You can do this by comparing the sentences with each other. . . . Notice that the foreign words are not always in the same order as the English words.

Ek piyala chae.	A cup of tea.
Yih chae bahut achchhi hai.	This is very good tea.
Chae bilkull taiyar hai.	Tea is quite ready.
Kab taiyar karoge?	When shall you make ready?
Main bahut pyasa hun.	I am very thirsty.
Bahut achchhi hai.	It is very good.
Yih mera rumal nahin hai.	This is not my handkerchief.

The writing of Crete still remains a riddle to which a happy discovery like the Rosetta Stone may provide the solution. Greek history and Greek legend, no less than the excavations of Knossos, Phaistos and elsewhere, all point to the conclusion that the successive Minoan civilisations of the island made an immense contribution to ancient civilisation, especially to the beginnings of maritime intercourse. The settled life we speak of as the New Stone culture starts very early in Crete, possibly ten thousand years ago or more, followed about 5,000 years ago by a Bronze Age believed to coincide with the first Egyptian dynasty and the Sumerian culture of Mesopotamia. It came to an end abruptly before the birth of the Greek culture in Asia Minor and the southern coast of Europe, having attained a very high level of achievement in architecture and pottery.

From the early Minoan Bronze Age we have gleaned many seals and objects engraved with symbols, about 140 in all. They are geometric figures, animals, parts of the body, what are clearly numbers, emblems suggestive of ships, grain. At this stage, as is true of all scripts in their beginnings, there is little regularity of arrangement; and we may infer that writing began in Crete as elsewhere by use of pictorial signs. From a later phase, we have remains of thousands of clay tablets with orderly left-right lay-out of symbols of remarkable simplicity; but we have no

38 *We have no clue to the meaning of the pictographic writing of the Minoan civilisation. Some of the characters recall the Cypriotic syllable signs, some the letters of the earliest alphabets. The later writing was a sound-script of 64 characters. (Cast of the Disc of Phaistos, 1800 B.C.)*

clues to suggest their significance. In the closing stage of Minoan civilisation there was in fact a sort of writing which relied on a very small battery of signs, 64 according to Diringer; and we can therefore infer that it was a sound-script. Some of the ingredients recall the form of Cypriotic syllable signs, others the form of letters of the earliest alphabets which came into being contemporaneously. A single master clue to the tablets of the Palace Archives in Knossos may at any time turn up unexpectedly, like the Rosetta Stone. If the excavator has such good fortune, it will immeasurably enrich our knowledge of a unique chapter in the history of civilisation.

FROM CAVE PAINTING TO COMIC STRIP 4

Much Ado About Nothing

Before a simple system of sound-writing came into widespread use, writing was necessarily a caste monopoly; but three millennia elapse between the dating of the first alphabets and the great enlightenment which will be our theme in the next chapter to this. Of the first millennium (1500–500 B.C.) there is little to record. Slowly, without any formal machinery of education, the use of alphabetic writing diffused along the great trade routes to the East. There is a growing class of traders and pilots with enough knowledge of letters to serve the needs of merchandise. There are also itinerant prophet-poets who can transcribe the sacred tradition and laws of the tribe. As yet, however, there is no organised literature of science other than the secret lore of the calendar priesthoods. During the second millennium there is a considerable growth of secular writing in the western world; and science has become an open conspiracy against ignorance. The source to which we must trace this efflorescence is a new impulse to writing simply, and at length, in the peculiar setting of the Greek ports and colonies of Asia Minor and the islands of the Mediterranean. Of that we shall have more to say in another context. What is relevant to our present theme is the fact that a secular literature of science began to flourish for the first time.

In so far as it had enduring value, the secular science of antiquity was essentially akin to that of its priestly parent. Astronomy, and mathematics as the handmaid of astronomy, were its main ingredients; but the mathematics and astronomy which flourished more especially in Alexandria from its foundation to the assassination of Hypatia by the monks of St. Cyril had a new preoccupation. The Greeks were maritime and heirs of the Phoenicians in the possession of a growing body of knowledge

39 *The numeral scripts of antiquity, born of the need to record numbers, were too cumbersome for the arithmetic of commerce. The counting-frame, or abacus, on which these Moscow children are learning to calculate, diffused along the trade routes of the Old World in very ancient times, and is still used.*

about the art of navigation. They had picked up in their travels as much as they could glean of the learning of the priesthoods of Egypt and Crete; and they had an eager appetite for more, when Alexander's armies effectively unlocked the treasury of priestly knowledge. Alexandrian science and geometry is the marriage of calendar technology, and all that goes with it, to the technology of navigation and exploration.

During the millennium which follows the rape of Alexandrian learning by ignorant monks, Europe fades out of the picture. A new confluence of technics has its main focus in Baghdad. There Arabic translations of Syriac versions of Alexandrian texts are available for study with those of Hindu mathematicians who have advanced the study of number series to a level higher than the Alexandrians attained. They had done so because India had accomplished a revolution in the technique of human communications. A change of number-symbolism as radical as the change from sign-script to sound-script was necessary before the art of calculation could become a common possession of literate mankind; and this accomplishment is the cultural debt of world civilisation to the civilisation of India. Laplace, the brilliant mathematical astronomer who assured Napoleon that God is not a necessary hypothesis, pays tribute to its epochal significance in these words:

> It is India that gave us the ingenious method of expressing all numbers by means of ten symbols, each symbol receiving a value of position, as well as an absolute value, a profound and important idea which appears so simple to us now that we ignore its true merit, but its very simplicity, the great ease which it has lent to all computations, puts our arithmetic in the first rank of useful inventions; and we shall appreciate the grandeur of this achievement when we remember that it escaped the genius of Archimedes and Apollonius, two of the greatest men produced by antiquity.

No further advance of those sciences which rely on mathematics would have been possible without this great reform; and if we record with distaste the sacrifice of Alexandrian scholarship on the altar of monkish superstition, we should also remember that such scholarship had outlived its capacity for healthy growth. The most deceptive of all the numeral systems of antiquity blocked further progress in mathematics beyond the peak from which Diophantus and Theon scanned the as yet unattainable horizon of algebraic analysis. The institution of slavery which discouraged contact between the literate class and the craftsman held in check discovery of new physical principles, if availability of the right sort of glass had in fact provided the means of extending Archimedean mechanics to the study of the gaseous state. The climatic setting was unfavourable to the design of mechanical clocks, when a more convenient device for recording local time than any available in the age of Ptolemy was prerequisite to fruitful extension of the principles of cartography.

Many seemingly unrelated events contributed to removing these obstacles; and scholars played a trivial role in doing so. The northward trek of European civilisation into cold and cloudy countries where windows were a necessity of comfortable living, and sundials of little use except as ornaments, created a demand for cheap transparent glass and nursed the mechanics of the clock. Liquidation of chattel slavery promoted the emergence of a class of free-born miners, precipitated the need for a new technology of mining and encouraged the spread of water power. A new ideology of solicitude for the sick and needy led to the foundation of hospitals and the introduction of spectacles. These and other circumstances all contributed to the great enlightenment of the century following the introduction of printing; but no single circumstance is of greater portent than the spread of the Hindu-Arabic numerals.

What distinguishes the Hindu-Arabic numeral notation from that of other Old World civilisations is the principle of *position*. The Roman notation employs the archaic principle of *repetition* (XXX) of separate symbols for each decimal magnitude: *units* (I), *tens* (X), *hundreds* (C) and *thousands* (M). The Hindu-Arabic system employs separate symbols (cyphers) for each of the integers from 1 to 9 and a zero, indicating an indefinitely large number of decimal magnitudes merely by the *position* the cypher occupies. This means that there is no limit, other than the size of the page on which we write it, for the size of a number which we can represent without recourse to new symbols; and the space requirements for large numbers are highly economical as is evident by comparison of 4,386 with MMMMCCCLXXXVI. The possibility of using the principle of position without invoking the principle of repetition depends on the use of a separate symbol for *nothing*. Without a zero symbol we could not

Numbers


Units
Example (1950)
Babylonian
1 10 60 600 3600
3 × 600 + 2 × 60 + 3 × 10
Egyptian
1 10 100 1000
1000 + 9 × 100 + 5 × 10
Greek (IONIC)
1 5 10 50 100 500 1000
1000 + 500 + 4 × 100 + 50
Roman
I V X L C IↃ CIↃ
1 5 10 50 100 500 1000
CIↃ IↃ CCCC L
1000 + 500 + 4 × 100 + 50
Mayan
1 5 20 100 360 1800
5 × 360 = 1800
7 × 20 = 140
10 × 1 = 10
Chinese
一 二 三 四 五 六 七 八 九 十 百 千
1 2 3 4 5 6 7 8 9 10 100 1000
一 千 九 百 五 十
1 × 1000 + 9 × 100 + 5 × 10
Sanskrit
१ २ ३ ४ ५ ६ ७ ८ ९ ०
१ ९ ५ ०
Arabic
١ ٢ ٣ ٤ ٥ ٦ ٧ ٨ ٩ ٠
١ ٩ ٥ ٠
Medieval
Modern
1 2 3 4 5 6 7 8 9 0
1950

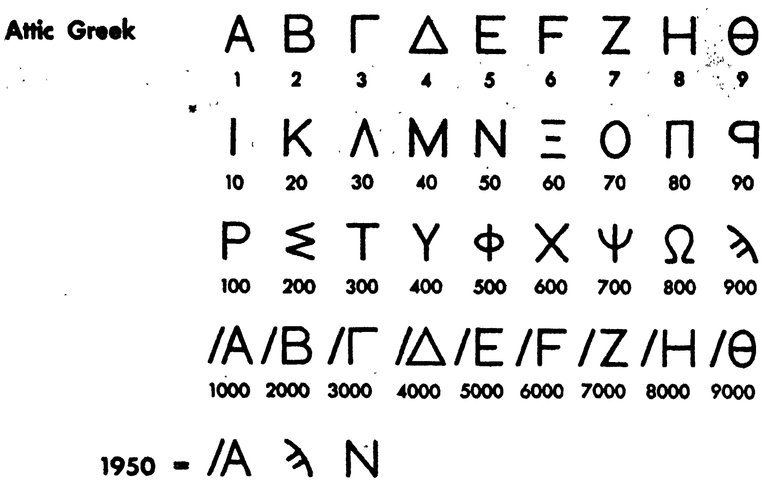
distinguish by recourse to position between 33, 303, 3,030, 3,300 *etc.*

The numeral systems of antiquity bear the stamp of two circumstances, the habit of counting on one's five, or rather ten, fingers and the calendrical preoccupations which signalise the first impulse to record large numbers. The Maya numerals include symbols (dots) for units repeated up to 4, a symbol (horizontal line) for 5 and a symbol for zero. Having the latter, they could do what we can do with our Hindu-Arabic numerals, in so far as they indicated magnitudes by position; but there was no dividend in this because successive groups of symbols do not refer to the same base. As our first position (extreme right) of a run of single cyphers signifies units up to 9, the first Maya position (vertically bottom) signifies so many units up to 19, the symbolic form of which was $\equiv$. The next Maya position (written above with a gap) signifies multiples of 20 as our next (to the left) signifies multiples of 10. If the third position of the Maya calendar numerals had signified a multiple of 400 (i.e. 20×20) as our third position refers to multiples of 100 (10×10), the Maya notation would have had the advantage the Hindu-Arabic numeral system owes to a combination of the principle of position and the consistent use of the same base—in our system 10 (hand counting), in theirs 20 (hand and foot counting). Actually, the third Maya position signifies 360, the fourth 7,200 (20×360). The new base in the third position shows the impress of the 360-day year of twelve 30-day months.*

The occurrence of a symbol for 60 in the Mesopotamian cuneiform number-scripts tells a similar story, since we know that the early Euphratean calendar had a zodiac of only six constellations to map out the sun's apparent circular track in the ecliptic belt. There were thus 6 double-months of 60 days in the 360-day year. Our division of the circle into 360 degrees is of course a relic of this; and the base 60 turns up in the division of the degree itself into 60 minutes each of 60 seconds. This co-existence of more than one base in such numeral scripts as those of the calendar-cultures of Guatemala and Mesopotamia is not surprising,

* Seemingly the Maya culture employed a consistent 20-base system of enumeration for purposes other than the calendar, possibly as an afterthought.

40 *Greece and Rome, still preoccupied with recording, used their alphabets to denote units, tens, hundreds and so on, and built large numbers by repeating the letters. The Hindu (Sanskrit) and Arabic notations, using a separate symbol for zero, were the first to denote units, tens, hundreds and so on by the position of the symbol. The Mayan number-script had a "zero"-symbol allowing magnitude to be indicated by (vertical) position, but failed to refer its groups of symbols consistently to the same base.*



41 *In search of an ever more economical way of recording numbers, the Greeks exhausted the resources of their alphabet. In this Attic Greek script, the symbols for 6, 90 and 900 were not in the alphabet, and the thousands require a double symbol. Arithmetic could not develop without a new system.*

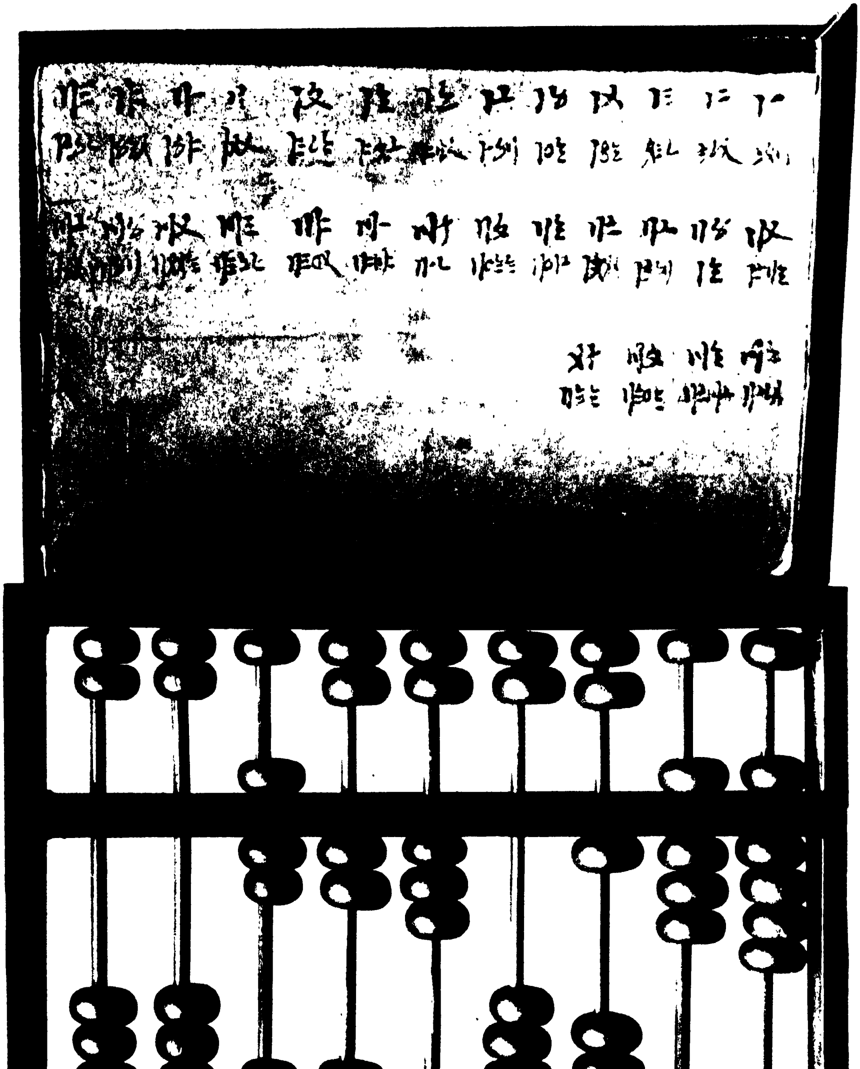
since our own verbal habits still disclose the inch and foot marks of our weights and measures. We use the base 10 consistently when we record numbers in sign-writing; but we speak of dozens or scores and transcribe them as such through the medium of sound-writing.

The adaptation of the number-signs of the priestly scripts to the needs of traders and pilots already equipped with a crude alphabet when the first vessels pushed northwards beyond the Strait of Gibraltar, registers an obsession consonant with the ideology of merchandise. The inconsistencies of a notation which had developed in association with the custody of the calendar and the leisurely book-keeping of its keepers did not constitute a problem of major importance, because the Egyptian hierarchy had in fact solved it by using one base (10) consistently; but the Egyptian notation was too cumbersome for the conduct of everyday affairs. The tempo of commerce demanded a less bulky method of recording numbers, and to that end invoked the new style of writing with letters. We may presume that the use of alphabetic symbols for different multiples of ten was originally a mnemonic trick, since *C* and *M* are the initial letters of Latin numerals implicit in our own words *century* and *millennium*; and a convention which would readily suggest itself to the first men to use the alphabet was easy to extend in the interests of economy of space with no prevision of the use of number-signs except as a means of recording operations performed with the counting frame.

Roman notation which added *V*, *L* and *D* as submultiples of 10, 100 and 1000 to sidestep recourse to repetition did not proceed far down the slope to Avernus. At a comparatively late stage it incorporated the trick of *inversion*, e.g. XL for XXXX, to reduce still further the load of repetitive signs carried by the old scripts; but it still bears the impress of its origin. Bit by bit, the Greeks lined up the alphabet in the search for an ever more economical way of writing down numbers, till they had exhausted its entire resources. When Alexandrian science took it over, the Greek system had forfeited the possibility of adapting itself to what we now regard as the main function of a numeral script. The late Attic Greek and Alexandrian numerals employed the first nine letters of an alphabet supplemented by the addition of archaic letters for the integers 1–9, the next nine for multiples of ten from 10–90, the next nine for multiples of a hundred from 100–900. If we did the same, a comparable code, supplemented with the old Teutonic þ, would be as follows:

$10^0=1$	$10^1=10$	$10^2=100$	*multiplied by*
a	j	s	1
b	k	t	2
c	l	u	3
d	m	v	4
e	n	w	5
f	o	x	6
g	p	y	7
h	q	z	8
i	r	þ	9

In this code we should represent 243 by *tmc* and 899 by *zri*. Circum-



locutory devices made it possible to represent thousands; but each new magnitude above a thousand had to call some new convention to its aid. The end result was certainly more economical as a record than the Roman notation, as is easy to see if we compare *tmc* = 243 = CCXLIII; but the simplest sort of calculation carried out in this symbolism presupposes the memorisation of a separate set of tables of addition, subtraction and multiplication for each decimal order of magnitude. It will help us to see how this handicapped the western world of antiquity, and to understand what we owe to the civilisation of India, if we successively perform a simple calculation first as Julius Caesar—or more likely Caesar's slave—would have performed it, then as we perform it with the Hindu-Arabic numerals. To clear the ground of misconceptions, we must familiarise ourselves with a very ancient mechanical aid to calculation still widely used in China, in Japan and in Moscow offices to this day.

Long before Caesar's time, men had invented a device for recording larger numbers than the human head can easily carry. To begin with, they probably did so by setting out pebbles in grooves of sand successively representing units, tens, etc. In whatever way the practice began, the *abacus* or counting frame diffused along the trade routes of the Old World in very ancient times. If the base of the numeral system is 10, the counting frame (Fig. 43) accommodates perforated beads on each of successive columns ordinarily allocated to different decimal orders of magnitude which we now write as $10^0 = 1$, $10^1 = 10$, $10^2 = 100$, $10^3 = 1000$ and so on. The rule of counting is that no column can carry more than 9 beads at a time. When we have need to add another bead to a column holding 9 already we have to *empty* it, and add a bead to the next column which records multiples of the next decimal magnitude. We call this operation *carrying over*.

If we have a means of carrying over, we can perform the addition of two large numbers without recourse to counting them one by one. It is merely necessary to memorise the addition of any pair of integers

42 *In this Chinese form of the abacus, each bead above the centre-line counts five, each below it, one. Only beads pushed to the centre-line count. The number recorded here is 7230189.*

from 1 to 9, a feat which we can learn easily before we reach our teens. Thus $3+8=11$ signifies that there would be 2 beads in excess of 9 on the unit-column, i.e. that we must empty it, carry over one bead to the ten column, and add one to the units column. Before the introduction of the Hindu numerals, the counting frame was the only way of accomplishing this carrying-over trick. To visualise clearly the process of adding two numbers of 3 cyphers in our notation, it is convenient to invoke three counting frames, two which respectively register the numbers we are to add together and a third which registers the result of combining them. Here is a simple example:

$$\text{CCLVI} + \text{CCCXLVII} = \text{DCIII}$$
$$256 + 347 = 603$$

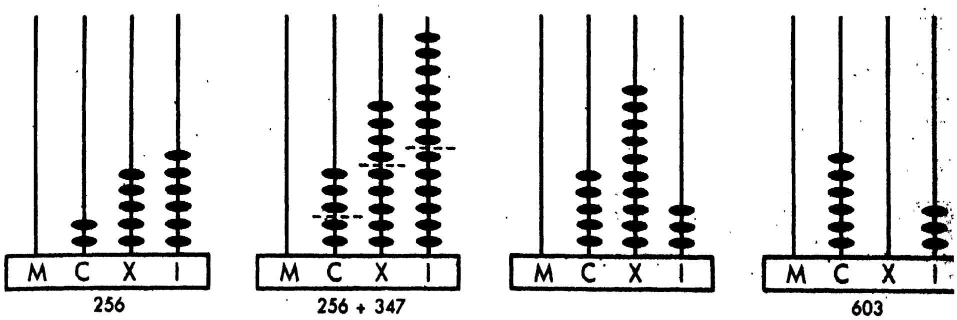
We may set out thus each step in transferring to the third the contents of the two counting frames which register 256 and 347 respectively:

C X I	C X I	C X I
3 4 7	3 4 0	3 0 0
2 5 6	2 5 0	2 0 0
0 0 0	0 1 3	1 0 3
3 4 0	3 0 0	0 0 0
2 5 0	2 0 0	0 0 0
0 1 3	1 0 3	6 0 3

What we actually learn to do at school is to perform the three stages of the 3-cypher operation simultaneously:

$$\begin{array}{r} 347 \\ 256 \\ \hline 603 \end{array}$$

The reason we can now do this carrying-over on paper without recourse to any mechanical aid is that we have a symbol for the *empty* column. In fact, the Hindu name for the zero symbol is *sunya* which literally means "empty". With its aid we need no symbols other than for the integers 1–9 to denote the number of beads on a column which is *not* empty. The principle of position then guarantees the possibility of representing



43 *Before the introduction of a symbol for zero, the trick of "carrying-over" was possible only on the counting frame. In this representation of the addition 256+347 the operation between frames two and three is: "add one to column X for 10 thrown out of column I", and between frames three and four: "add one to column C for 10 thrown out of column X".*

numbers as large as we like without recourse to any new device; but this convenience of the new notation is less important than the fact that we are now free to use numbers in a new way. Previously, we have used numbers merely to *record* computations carried out by an instrument without which we are helpless; and we are helpless because our code is not a description of the lay-out of the counting frame itself. Our new code, complete with a symbol for the empty column, is a visual model of the instrument. Because our number symbols record the way it works, we are now able to let them tell their own story. In short, we can use our symbols *operatively*. We make numbers do work on paper, and we no longer need the counting frame to do the work for us.

The mathematical genius of the Alexandrians utterly failed to appreciate the possibility of so simple a reform of the defects of the numeral notation they inherited from an earlier civilisation. To achieve it, a fresh start was necessary at a less sophisticated level. The adoption of the new symbolism arises in the practice of the counting house where there is no incubus of sophisticated tradition. For Hindu mathematics did not give birth to zero. The dawn of nothing in the poem of Omar Khayyâm is the portent of the birth of Hindu mathematics. Once it was possible to make numbers operate freely on paper—or papyrus—it was possible to study the natural history of numbers in a new way.

A lively appreciation of this dichotomy helps us to understand the character of ancient mathematics, and also to understand how unnecessarily its preoccupations still hold up the humanisation of mathematical instruction in our schools. In the western world of antiquity, there is a tradition of number-lore older than the use of the abacus—the method of the scale diagram. A single example will illustrate its use (Fig. 44). A theorem of Euclid, well known to the Mesopotamian priesthoods more than two thousand years before his time, exhibits the rule:

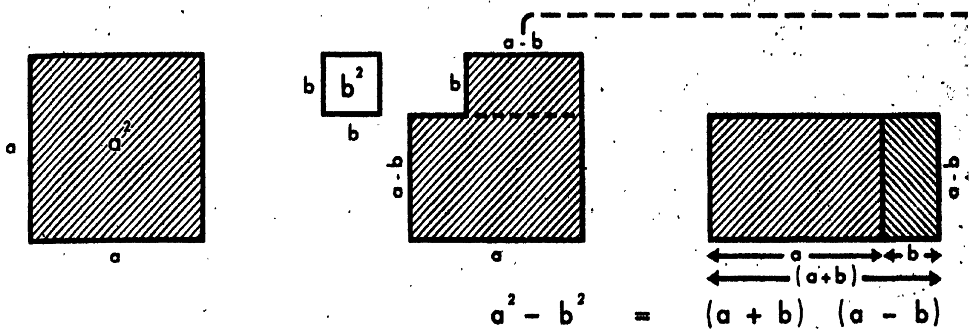
$$(a+b)(a-b) = a^2-b^2$$

If we substitute 20 for *a* and 3 for *b*, this expresses the identity:

$$(20+3)(20-3) = 20^2-3^2$$
$$\therefore \quad 23\times 17 = 400-9 = 391$$

To apply this rule we have merely to make use of the fact that half the difference between 23 and 17 is 3. If we have a table of squares, we can then get our answer more cheaply than by successively putting 23 on the abacus 17 times. The calendar priesthoods of Mesopotamia did have such tables. Excavations at Nippur have unearthed a library of clay tablets exhibiting the squares of the natural numbers.

This example suffices to drive home the lesson that ancient geometry had to shoulder many tasks which we no longer regard as geometrical problems, and on that account was the major part of ancient mathematics. The defects of the number-scripts of the ancient world also explain an orientation which still has a baneful influence on the teaching of geometrical principles. The fundamental rules of Alexandrian geometry are at most about a dozen, and it is possible to exhibit them as an orderly logical sequence if we introduce at an early stage the rule which is the basis of trigonometry, i.e. the proportionality of corresponding sides of equiangular triangles. That Euclid devotes a dozen volumes to the lay-out of his system receives a very simple explanation from the fact that he devotes a whole volume, the fifth, to a discussion of the concept of propor-



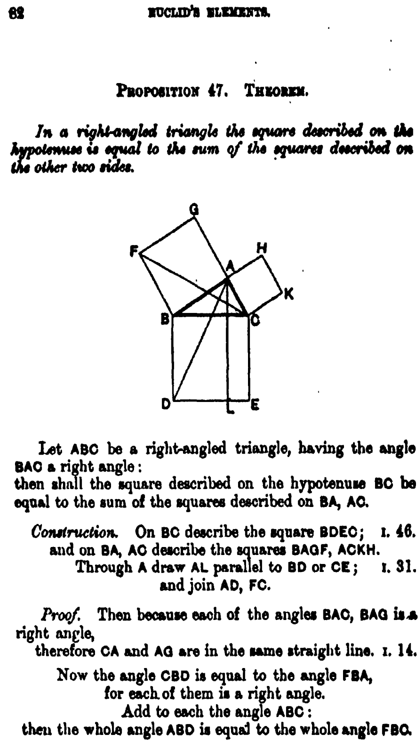
44 *The tradition of the scale-diagram in the western world is even older than that of the abacus. The theorem of Euclid shown visually above and algebraically opposite was used in calculation by the Mesopotamian priesthoods more than 2,000 years before his time.*

tion. This now offers no difficulty to a bright child of ten, already familiar with batting averages, miles to the gallon, percentages and so forth.

It is not difficult to understand Euclid's own difficulty. What is more difficult is to understand why the schoolbooks perpetuate it. To visualise the operation of division as a process which we can extend indefinitely was impossible till mathematics cast off the strait-waistcoat of an alphabetic numeral notation. It is within the comprehension of a child when we take advantage of a facile extension of the operation of the counting frame by representing fractions as tenths, hundredths and so forth; and when we have taken this step, other problems which provoked endless disputation among the best mathematicians of the ancient world cease to puzzle us. One such is what mathematicians call *convergence of series*. A convergent series is an indefinitely long sequence of numbers whose sum never exceeds a certain limiting figure, e.g.

$$1 + \frac{1}{10} + \frac{1}{100} + \frac{1}{1000} + \frac{1}{10000} + \frac{1}{100000} + \frac{1}{1000000} \quad \ldots .$$

The mathematicians of antiquity experienced the greatest difficulty in



62 EUCLID'S ELEMENTS.

PROPOSITION 47. THEOREM.

In a right-angled triangle the square described on the hypotenuse is equal to the sum of the squares described on the other two sides.

Let ABC be a right-angled triangle, having the angle BAC a right angle:
then shall the square described on the hypotenuse BC be equal to the sum of the squares described on BA, AC.

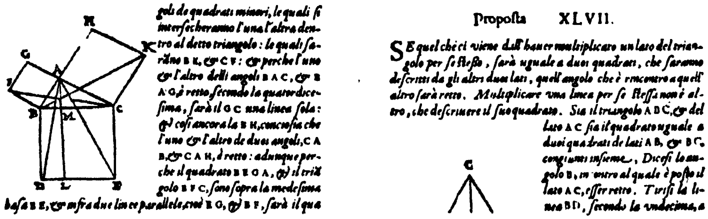
Construction. On BC describe the square BDEC; I. 46.
and on BA, AC describe the squares BAGF, ACKH.
Through A draw AL parallel to BD or CE; I. 31.
and join AD, FC.

Proof. Then because each of the angles BAC, BAG is a right angle,
therefore CA and AG are in the same straight line. I. 14.
Now the angle CBD is equal to the angle FBA,
for each of them is a right angle.
Add to each the angle ABC:
then the whole angle ABD is equal to the whole angle FBC.

45 *Defects in the number-scripts of the ancient world led Euclid to devote twelve volumes to a geometry of which the fundamental rules are at most about a dozen, a laborious tradition which still persists in the schoolbooks. These three presentations of Pythagoras' theorem (left) from Tabit Ibn Qorra's translation of Euclid, A.D. 890; (opposite) from a sixteenth-century Italian manual, and (right) from Hall and Stevens' Geometry, 1898, show little change in method.*

accepting the fact that it is possible to reach a limit by piling up smaller and smaller numbers indefinitely; and there is nothing to suggest the fact that it would do so, if we write it in the form:

$$\mathrm{I} + \frac{\mathrm{I}}{\mathrm{X}} + \frac{\mathrm{I}}{\mathrm{C}} + \frac{\mathrm{I}}{\mathrm{M}} \ldots\ldots\ldots\ldots\ldots\ldots \textit{and so on}$$



goli de quadrati minori, le quali si interseccheranno l'una l'altra dentro al detto triangolo: le quali saranno B K, & C F: & perche l'uno & l'altro delli angoli B A C, & B A G, è retto, secondo la quatordicesima, sarà il G C una linea sola: & cosi ancora la B H, conciosia che l'uno & l'altro de duoi angoli, C A B, & C A H, è retto: adunque perche il quadrato B E G A, & il triangolo B F C, sono sopra la medesima basa B E, & infra due linee parallele, cioè E G, & B F, sarà il qua

Proposta XLVII.

SE quel che ci viene dall'hauer multiplicato un lato del triangolo per se stesso, sarà uguale a duoi quadrati, che saranno descritti da gli altri duoi lati, quell'angolo che è rincontro a quell'altro sarà retto. Multiplicare una linea per se stessa non è altro, che descriuere il suo quadrato. Sia il triangolo A B C, & del lato A C sia il quadrato uguale a duoi quadrati de lati A B, & B C, congiunti insieme, Dicesi lo angolo B, in contro al quale è posto il lato A C, esser retto. Tirisi la linea B D, secondo la undecima, a

Let us now write it in the positional notation which we have to-day:

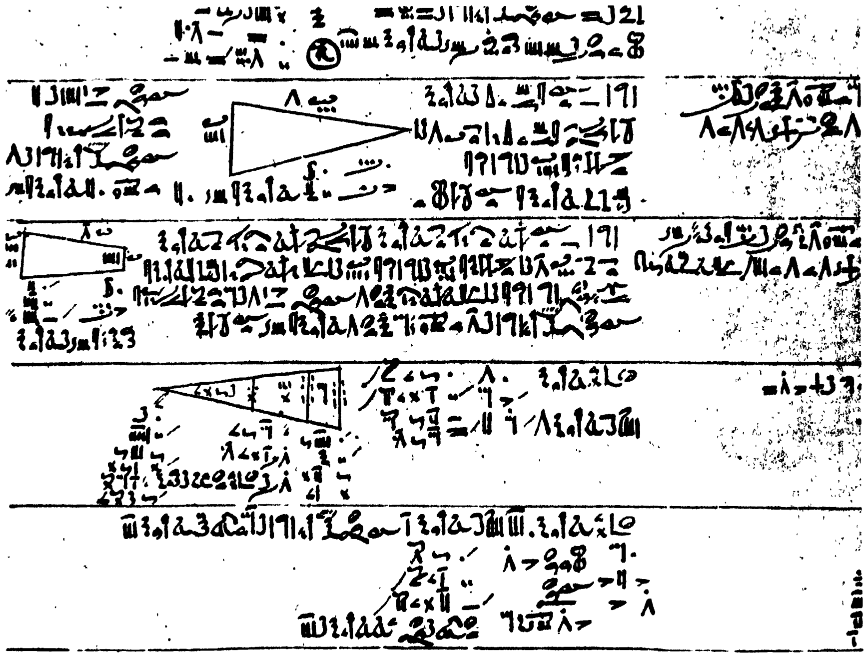
$$1+0{\cdot}1+0{\cdot}01+0{\cdot}001+0{\cdot}0001 \ldots\ldots\ \textit{and so on.}$$

It is now obvious that this is $1{\cdot}1111\ldots = 1{\cdot}\dot{1}$ or one and one-ninth.

In this context, we have used the expression *and so on* too light-heartedly. The fact is that the numeral scripts of the ancient world did not accommodate symbols to exhibit explicitly a process of piling up which really does go on indefinitely. Archimedes, perhaps the most brilliant geometer of the Alexandrian world, and the one who would be memorable if only because he recognised the need for a radical reform of its number-script, wrote a tract called the *Sand Reckoner* to dispel a widely current illusion that limited the number of enumerable objects in the universe to the number of available symbols for specifying their totality. It goes without saying that the astronomy of Eratosthenes and the trigonometry of Hipparchus staggered under a crippling burden of inconvenience due merely to the fact that their numeral symbols were so ill-adapted to record astronomically large numbers or approximate values of fractions. Fractions were particularly intractable. The Greek treatment of fractions did not advance an inch beyond the Rhind papyrus of the scribe Ahmes. The mathematicians of antiquity could compare fractions only in a metaphorical way as we divide dollars into cents or nickels; and took extraordinary and fruitless trouble to exhibit them as sums in the form:

$$\frac{2}{43} = \frac{1}{43} + \frac{1}{86} + \frac{1}{129} + \frac{1}{258}$$

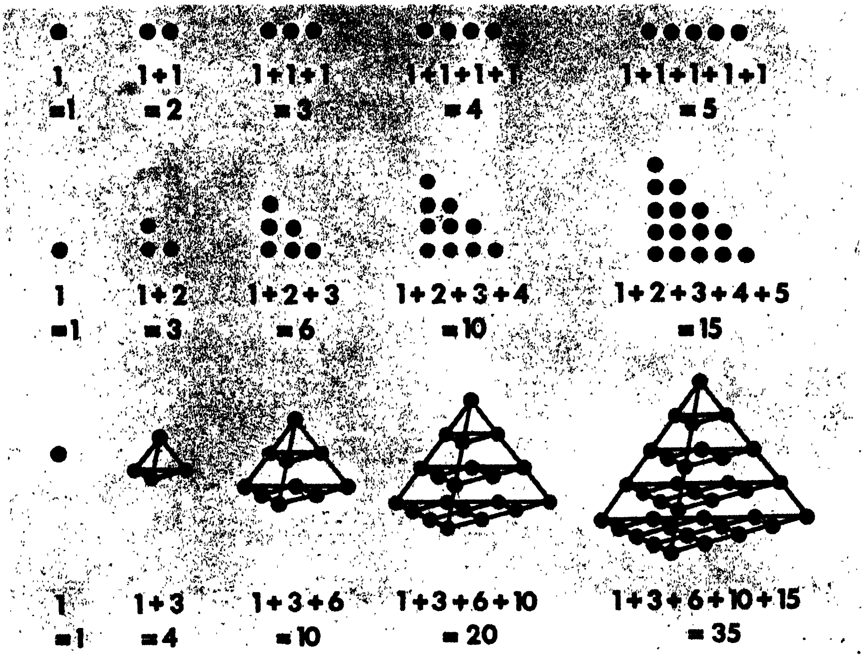
The scale-diagram method was not the only way of sidestepping the abacus in the ancient world. An alternative technique of visualisation, too little exploited in contemporary education, has a close tie-up with



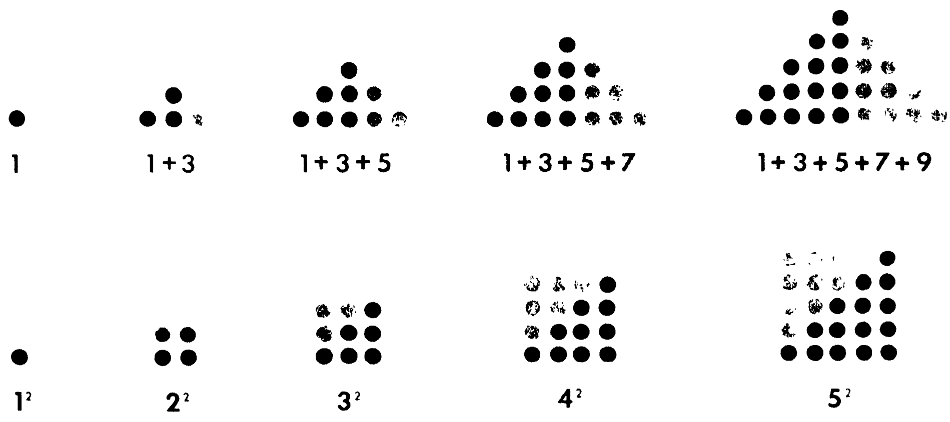
46 *Fractions were particularly intractable in the ancient number-scripts. The last section of this part of the Rhind Papyrus asks: "What equal areas should be taken from 5 fields (each of one setat) if the sum of these areas is to be 3 setat?" The argument runs something as follows: "Multiply 5 so as to get 3; once 5 is 5; one-half 5 is two and a half; one-tenth 5 is one-half. Therefore (take from each field) one-half and one-tenth." The Greek methods were no advance on this.*

early Greek speculations about the particulate structure of matter. Tradition suggests that the Pythagorean brotherhoods of the sixth century B.C. learned this device of *figurate numbers* (Fig. 47) from Eastern sources. This is not unlikely, and if true would explain much that is characteristic of Hindu mathematics when it came to maturity under the stimulus of a new opportunity for meeting a long-standing need.

The efflorescence of Hindu mathematics follows the fall of Alexandria and bears the stamp of its positive achievements; but the new notation antedates it by several centuries. The introduction of *sunya*, at first a dot,



47 *Figurate numbers, as well as scale-diagrams, provided the ancients with a convenient way of side-stepping the abacus. These modern examples exhibit the build-up of the number series which intrigued the Pythagorean brotherhoods and can simplify the rationale of statistical theory to-day.*



48 *By the fifth century A.D. the Hindu positional system had established a new freedom to operate with numbers. In this twelfth-century Bakhshali MS., an exercise on the numbers of chariots, elephants, horse and foot in an army, the dot-zero is clearly seen and the 3 is approximating to its modern form. The number "(foot) 109350" is recognisable bottom centre.*

seems to have occurred in the first half of the second century A.D. By that time the signs for the first three integers had assumed a shape which anticipates the way in which we now write them. Like all the ancient scripts, those of the Far East originally employed the principle of repetition which recalls man's first attempt to record numbers by chipping successive marks on wood or stone; but the lay-out was horizontal. Thus they use — 二 三 where the Romans in conformity with Egyptian practice use I, II, III. In India the joint dictatorship of the writing implement and writing surface imposed at an early date on the symbols for the second and third integers a cursive form more convenient for rapid transcription as z and ẓ ; and it requires little imagination to appreciate how a progressively more flowing style of writing ironed out the angularities.

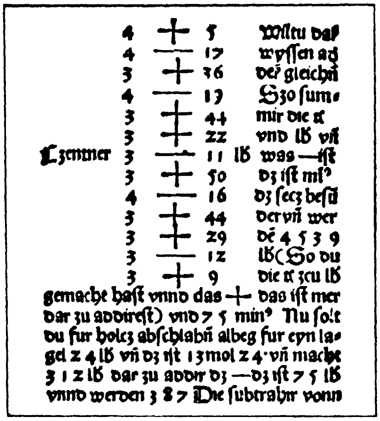
When a literature of Hindu mathematics begins in the fifth century of our era, there is already ample evidence of progress in the execution of tasks which the Alexandrians had undertaken with brilliant ingenuity bogged up by their inflexible battery of numeral signs. For instance, Hipparchus (about 150 B.C.) had given trigonometry a flying start with a table of sines in intervals of $7\frac{1}{2}°$. The Lilavati of Aryabhata, composed about A.D. 470, gives a similar table in intervals of $3\frac{3}{4}°$. A century before Hipparchus, Archimedes had shown that the value of π lies between 3·140 and 3·142 in our notation, and none of his successors did better. The Lilavati gives the value 3·1416 which for nearly all practical purposes is adequate. We recapture the feeling of this new freedom to operate with numbers to any order of precision, if we recall the fact that Al Kashi (about A.D. 1430) cites the value of π as 3·14159265358979 32.

The pioneers of Hindu mathematics, Aryabhata and his successor Brahmagupta in the sixth century, already operated with fractions in the modern way, writing them without the bar, e.g. $\begin{smallmatrix}3\\4\end{smallmatrix}$ for $\frac{3}{4}$; and Mahavira (about A.D. 850) gives the rules for manipulating fractions in words which a schoolteacher of to-day might use. By that time, the groundwork of a new technique of calculation was complete. Aryabhata and Brahmagupta were familiar with the law of signs which Diophantus had deduced by the geometrical method of his time, in modern dress:

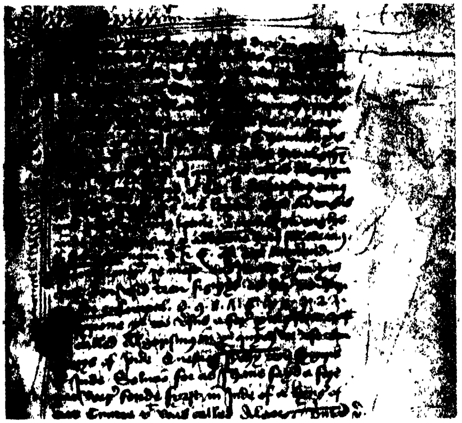
$$(a+b)(c+d)=ac+ad+bc+bd$$
$$(a+b)(c-d)=ac-ad+bc-bd$$
$$(a-b)(c-d)=ac-ad-bc+bd.$$

They had also formulated two rules essential to the act of carrying-over in addition or multiplication, which is merely repetitive addition. We ourselves write them succinctly in the form $a \pm 0=a$; $a\times 0=0$. They had to rely on words to express the rules, but the new numbers could tell their own story, if a somewhat long story. It was now possible to set out—though still at a verbal level—the solution of simple equations without recourse to scale diagrams. In short, the essential rules of what we now call by a Greek name *arithmetic*—a very different discipline from the Greek number-lore—had taken shape when Baghdad became the Mecca of science in the middle of the ninth century.

The Moslem mathematicians and their Hindu contemporaries persisted in a technical task which the pioneers had undertaken with un-



4 + 5 Wiltu das
4 — 17 wyssen ad
3 + 36 der gleichn
4 — 19 So sum
3 + 44 mir die ℓ
3 + 22 vnd lb vn
Czentner 3 — 11 lb was — ist
3 + 50 dz ist min⁹
4 — 16 dz secz besu
3 + 44 der vn wer
3 + 29 de 4 5 3 9
3 — 12 lb(So du
3 + 9 die ℓ zcu lb
gemacht hast vnnd das + das ist mer
dar zu addirest) vnd 7 5 min⁹ Nu solt
du fur holcz abschlahn albeg fur eyn la-
gel 24 lb vn dz ist 13mol 24· vn macht
3 1 2 lb dar zu addir dz — dz ist 7 5 lb
vnnd werden 3 8 7 Die subtrahir vonn



49 *By the close of the twelfth century the techniques of Moslem mathematicians had diffused through the Mohammedan world and into Christendom. In A.D. 1300 a manuscript book, the "Craft of Nombrynge" (right) was circulating in Britain. Succeeding centuries added to the battery of mathematical symbols. In Widman's commercial arithmetic, 1489 (left), the signs for plus and minus appear.*

foreseen consequences. To make better tables of the sines of angles for astronomical and geographical lore which the Moslem world advanced considerably beyond the content of Ptolemy's *Almagest* and the *Geographia* of the same author, it was necessary to use better approximate values of the square roots of numbers which are not themselves perfect squares. At a very early stage in the growth of this new science of computation, the Hindus had begun to explore a trick which depends on the identity we write as: $\sqrt{ab} = \sqrt{a}.\sqrt{b}$. This means that $\sqrt{200} = \sqrt{100}.\sqrt{2} = 10\sqrt{2}$, hence by recourse to one way of writing fractions $\sqrt{2} = (\sqrt{200}) \div 10$. The nearest perfect square to 200 is $196 = 14^2$. So we can write as a first approximation $\sqrt{2} = 14 \div 10$. As a second approximation we can put $\sqrt{2} = \sqrt{20000} \div 100$, and the whole number whose square is nearest to 20000 being 141, we now have as a better value $141 \div 100$. For economy of transcription, no doubt suggested by the fact that the abacus could now extend its columns indefinitely on paper, it became the practice to write such successive approximations as 1 4 and 1 41 *etc.*

with a gap where we now insert a mark of punctuation. Thus emerged the notation of decimal fractions.

It is not pertinent to our theme to write at length of work during the same century by Moslem scholars such as Alkarismi who perfected rules —the *algorithms*—we now learn in childhood, nor to catalogue the achievements of later ones among whom Omar Khayyâm is memorable for his discovery of the ground-plan of what we now call the binomial theorem. It suffices to say that the fruits of their labours had diffused through the Mohammedan world when the Moorish universities of Spain lit a beacon in the darkness of the European continent. An early token of the assimilation of the new numerals by Christendom comes from the focal point of culture-contact. It is a Sicilian coin struck in the year A.D. 1124. The innovation met with minor clerical opposition; but the needs of emergent commerce especially in Italy and in Germany, where merchants ruled the roost, ensured an eager audience for a tool so time-saving in the counting-house. The *Liber Abaci* composed by Fibonacci about A.D. 1228 was the parent of many other treatises which introduced merchants and craftsmen to the use of it. By about A.D. 1300 a book in manuscript on the *Craft of Nombrynge* was circulating in Britain. Throughout the fourteenth century, there was a German guild of arithmeticians (*Rechenmeister*), skilled in the algorithms; and the first century of printing from movable type launched on the European book market a succession of commercial arithmetics.

These are notable for a feature to which we shall refer at a later stage. The Hindus and Arabs transmitted the rules of calculation at a *verbal* level. The only sign they employ other than the cyphers is the square root (*surd*) sign $\surd$. In Widman's commercial arithmetic published at Leipzig in 1489, we encounter the signs $+$ and $-$. That of Record, an Englishman of the succeeding century, introduces $\times$ and $=$. Not without reason does Tobias Dantzig in his fascinating book entitled *Number* assure us that:

> . . . the mathematical inventions which have proved to be the most accessible to the masses are also those which exercised the greatest influence on the development of pure mathematics.

Printing, Paper and Playing Cards

Twenty thousand years or more separate the way of life of the Aurignacian hunters, who contributed the first pictures to the modern symposium of human communications, from the beginnings of settled community life and the beginnings of a priestly script. Fully three thousand years separate the way of life of the first Semitic trading folk who had an alphabet from the vast expansion of knowledge which occurred in Northern Europe after the spread of printing from movable type during the half century before the voyages of Columbus. Civilised mankind had to surmount many hurdles before it was possible to exploit to the fullest extent the considerable economy signalised by the introduction of alphabetic writing.

At first, there were few people who had any use for the art of writing except as a convenience of commercial intercourse. There was in fact no incentive to adapt the art of writing with letters to the flexible uses of daily speech. Save for one circumstance, the theme of G. Thomson's already mentioned treatise *Aeschylus and Athens*, progress to that end might indeed have been slower. An age-long popular tradition of community singing and community dancing lies back of Aeschylus, Euripides and Aristophanes; but it was one which could assume so novel an aspect only in the trading communities of the islands in the Mediterranean, where constant interchange of personnel promoted conditions less propitious to the dominance of a priestly class of avaricious landed proprietors than under the earlier dynasties of Egypt and the near East. Thus and there, at an early date, a segment of tribal ritual crystallises as a secular pursuit; and where there is a flourishing drama there is also a motive for writing, equally aloof from association with the repetition of sacred

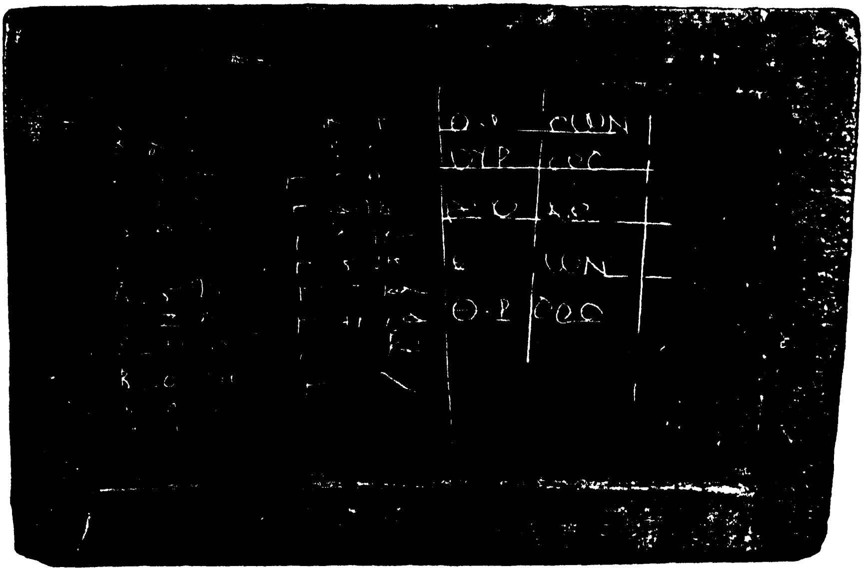
50 *Three thousand years separate the appearance of the first alphabet from the invention of printing with movable type, and the sudden expansion of knowledge which followed it. Civilised mankind had to surmount many obstacles before he learned to exploit the economy of alphabetic writing.*

texts or from the limited requirements of the counting-house. There is, in fact, an incentive to write down what is more than a ceremonial password, an epitaph or a bill of goods, an incentive to record in writing what living people actually speak.

It is indeed a far cry from the Greek drama to the free-and-easy visual speech of a modern novel or of a modern newspaper in the western world; but we unduly belittle our too often overrated debt to Greek civilisation, if we fail to pay tribute to an innovation which entitles Greek literature to rank as a cardinal contribution to the self-education of the human species. To a far greater extent than the Romans, the Greeks wrote about the life of their times with an intimacy and liveliness which foreshadows the adaptation of writing to all the familiar uses of speech. For the Latin which generations of schoolboys reluctantly construed in the grammar schools, Latin in the Gladstone tradition, was actually dead when committed to writing, a language as remote from the common speech of the Italian peninsula as the idiom of Gertrude Stein from that of the contemporary American household.

Within the framework of Greco-Latin society, the written word became available to the more prosperous citizens on a scale unprecedented in the civilisations which had preceded them; but there were still very few who read much or read often. The spoken word was still the main instrument of instruction and of political persuasion. Even among those who could read, there were still few who could also write. There were in fact two formidable impediments alike to the use of the written word as a medium of instruction or of propaganda and to the availability of any considerable body of written matter for those with inclination and training in the art of reading. Needless to say, one was the laborious nature of the only available means of multiplying the products of the pen, when it was necessary to copy every script individually by hand; and since this was a labour commonly entrusted to slaves, deficiency in penmanship gave little affront to self-esteem among the still privileged

51 The use of the alphabet to record the intimacy and liveliness of speech began with the drama of Greece. These examples of writing on the convenient, smooth-surfaced papyrus are (left) second-century fragments of Sophocles' "Ichneutae"; (right) letter from Artemidoros to Zenos, 255 B.C.



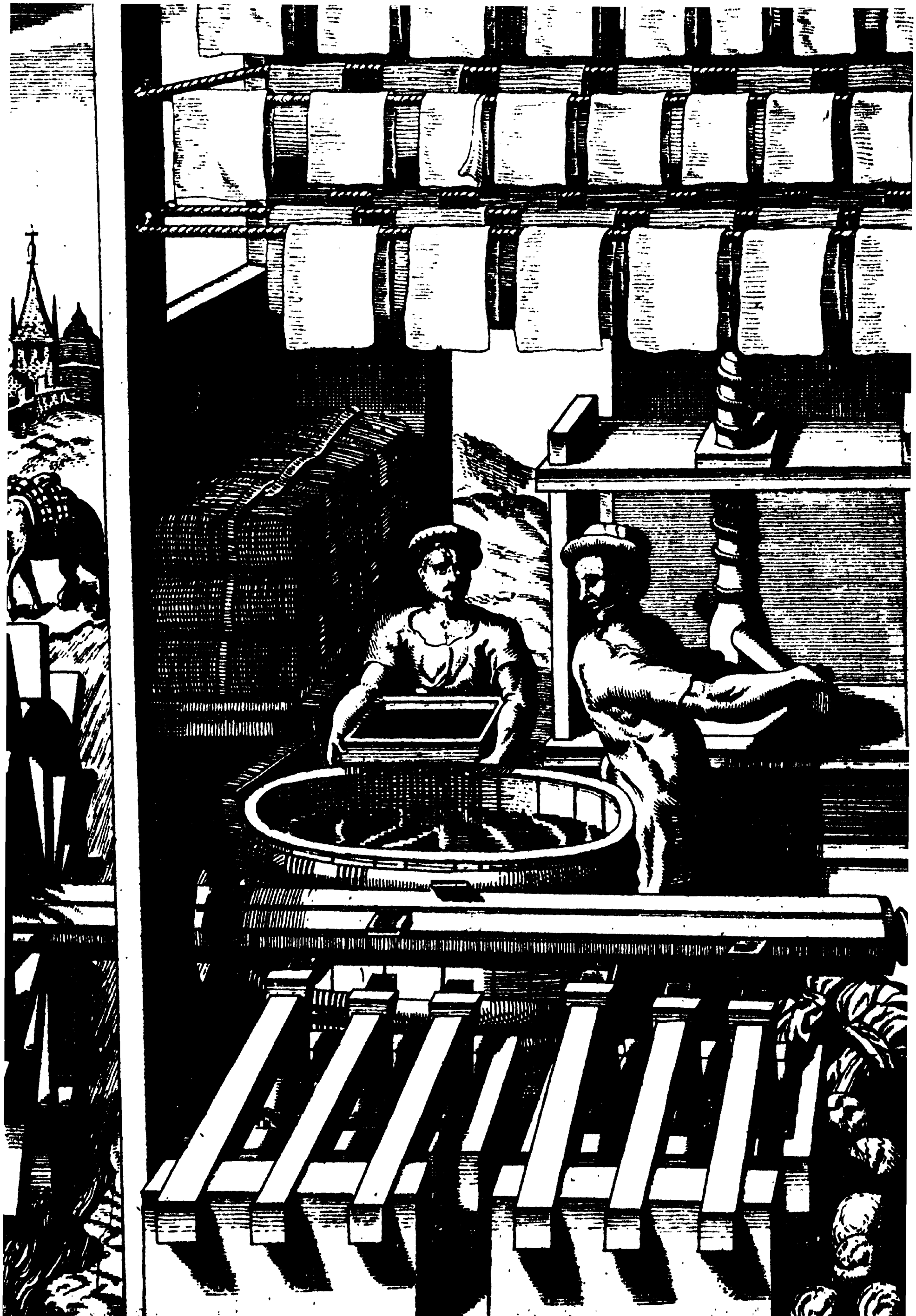
52 *The bulkier writing surfaces of the ancients limited the advance of literacy. This Greek wax tablet of the second century B.C. reads (first column) 1 1 1, 2 1 2, 2 2 4 . . . (second column) 3 1 3, 3 2 6 . . . Clearly the left half is a multiplication table.*

few who could read with ease. The other handicap was the writing surface itself, often of its very nature inadaptable to free circulation and at best costly.

Paper is so much a part of everyday life that we too easily overlook the significance of writing material as a circumstance limiting the advancement of literacy. It is on that account worthy of more than a single sentence. The clay tablets of Babylon and Crete might serve the purpose of stocking a temple or a palace library; but no household of modest size could have accommodated the contents of several issues of the *New Yorker*, if transcribed in the cuneiform tradition. Much the same may be said about the wax tablets in common use among the Roman contemporaries of Cicero. Indeed the advantage Egyptian civilisation, and thereafter the mainland Greek, Alexandrian, and late Latin, enjoyed from the use of *papyrus* is difficult to exaggerate. Papyrus consists of longitudinal ribbons of reed laid on a wet surface, stuck with gum to an overlaying layer of similar strips at right angles, dried in the sun and subsequently polished. It has a double advantage over clay and wax. It is not bulky, and its smooth surface permits an easy cursive style of writing. On the other hand, its manufacture is tedious; and it does not stand up to a moist climate.

Long before printing began in Europe—during the Han dynasty in the first century A.D.—the Chinese had taken a lesson from the wasp, which makes its nest by chewing vegetable fibre and pressing the moist suspension into a film of even thickness. As a source of vegetable fibre, the Chinese used anything which came to hand: old fishing nets, worn-out rope and hemp, macerating it in tubs before removing with a sieve the artificial detritus. It is then possible to compress the latter to required thickness, and the triturated fibres adhere when dry. The Mandarin had now material far superior to papyrus, alike for copying or for storing the written word; but he lacked the incentive to share the advantage of this invention with his underprivileged compatriots. Chinese literature received a new impetus; but there were still few who could enjoy its benefits. By making paper available, China conferred on civilisation as a whole a reward far greater than the country of its origin has yet reaped.

The capture of Samarcand by the Arabs in A.D. 750 marks the date when paper starts on its trek to the as yet non-existent printing presses of Europe. The Moslem invaders of Spain and Sicily brought it with them into the territories they conquered, and with it a recipe for deriving the fibre basis from old rags. For three centuries after its introduction to Christendom, somewhere about A.D. 1200, it had to compete with parchment or vellum made from stretched, pressed and dried animal membranes. What was probably decisive in establishing its supremacy was the spread of water mills in the two centuries before Caxton. Power was necessary to speed up maceration of the raw material; and we have record of paper mills in Germany by A.D. 1336. Had it not been for this new tempo and economy of production of thin, smooth and flexible



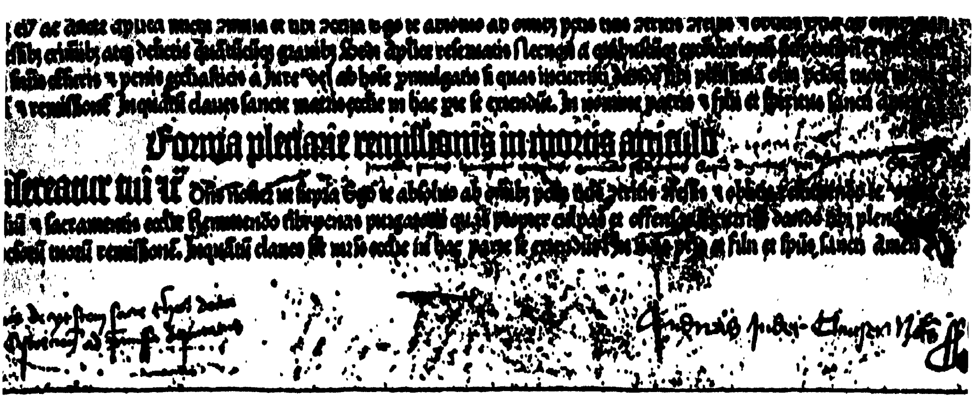
material for the impress of the written word, the vastly increased volume of written matter put into circulation by the printing press could not have come about.

As we all know, printing from movable type began in Europe about fifty years before Columbus set out on his first voyage; but few of us reflect upon the dramatic speed with which the new trade spread from one city or one country to another. A single leaf of a sibylline poem called the *Fragment of the World Judgment* is supposedly the earliest extant product of the new technique, probably issued about the year 1445 from the press of Gutenberg, a master printer then resident in Strasbourg. From law-suit records we know that Fust, a goldsmith of Mainz who financed Gutenberg's earliest trials, was printing there during the fifties; and McMurtrie, author of *The Book,* states that

> the first *dated* piece of printing preserved to us appeared in 1454, which is thus the earliest date that can be set beyond any speculation or controversy. In that year four different issues of a papal indulgence appeared in printed form. The occasion was historic. Constantinople had fallen to the Turks the year before. At the solicitation of the king of Cyprus, Pope Nicholas V granted indulgences to those of the faithful who should aid with gifts of money the campaign against the Turks. Paulinus Chappe, as representative of the king of Cyprus, went to Mainz to raise money for this cause. Ordinarily, these indulgences would have been written out by hand, but in this case, as there were a considerable number to be distributed, the aid of the new art of printing was enlisted, and forms were printed with blank spaces left for filling the dates, the names of the donors to whom they were issued, and other details.

The new art turned out to be a double-edged weapon in the hands of papal authority. A Latin Bible in two columns of forty-two lines to the page came out in 1456, most probably, according to McMurtrie, from the press of Fust, now in competition with Gutenberg. As early as 1478, a Cologne master printer issued a Bible in two different German dialects with well over a hundred illustrations. There were 133 editions of it during the next fifty years. To be sure, a century was to elapse before printed Bibles were available in the home tongue throughout Germany, Britain, Scandinavia and the Low Countries; but it was a disastrous step to make the poorer clergy Bible-conscious.

53 *It was not until the Moslem invaders brought paper to Europe that the problem of writing surface was solved. Supremacy over vellum was established during the century before Caxton, when watermills brought a new tempo and economy of production. (From a woodcut published in 1662.)*



54 In 1454 Pope Nicholas V issued a printed indulgence, of which part is shown above. It was the first dated specimen of printing from movable type. Two years later came the publication of Gutenberg's famous 42-line Bible (right, prologue and Chapter I of St. Luke's Gospel). The ground was well prepared; the new craft spread with dramatic speed.

Within ten years of the issue of the Indulgence mentioned above, printing by movable type was going on in several German cities other than Mainz and Strasbourg. German printers brought the art to Rome in 1467, and two years later John of Spire, like Fust a goldsmith, had started work in Venice. In Switzerland, says McMurtrie, it seems likely that "the first printing office in Basle began work about 1467". Printing in Paris starts about a year later. In 1469, Caxton, a Kentishman, who had occupied consular status to the English Merchant Adventurers at Bruges, began translating into his own tongue for the press the *Recuyell of the Histories of Troye*, printed there in 1475. A year later, he returned to England, set up business with Colard Mansion in the Almonry near Westminster Abbey, and from that office produced *The Dictes or Sayengis of the Philosophers*. This, states McMurtrie,

> was the first dated book printed in England, the Epilogue being dated 1477 and in one copy November 18. Though this was the first *dated* book, it was not certainly the first issue of the press, Caxton's translation of Jason and a few other publications of slight extent having probably preceded it.

Within twenty years from the start, on the threshold of the discovery of the New World, printing from movable type is thus in full swing

Lucas syrus natōe anthi-
ocensis · arte medic⁹ · disci-
pulus apostoloꝝ · postea
paulū secut⁹ usq; ad con-
fessionē eius serviens dño sine crimine:
nam neq; uxorem umquā habuit neq; fi-
lios: septuaginta et quatuor annorū
obijt in bithinia · plen⁹ spiritu sancto.
Qui cū iam scripta essent euāgelia · p
matheū quidē in iudea · p marcū autē
in italia: sancto instigante spiritu in
achaie partibz hoc scripsit euangeliū:
significans etiā ipse in principio ante
suū alia esse descripta. Cui extra ea q
ordo euāgelice dispositionis exposcit-
ea maxime necessitas laboris fuit: ut
primū grecis fidelibz omni ꝓphetati-
one venturi in carnē dei cristi manife-
stata humanitate ne iudaicis fabulis
attenti: in solo legis desiderio tenere-
tur: vel ne hereticis fabulis et stultis
solicitationibz seducti exciderent a ve-
ritate elaborarent: dehinc · ut in princi-
pio euangelij iohānis natiuitate pre-
sumpta · cui euangelium scriberet et in
quo elect⁹ scriberet indicaret: contestās i
se cōpleta esse · q essent ab alijs incepta.
ta. Cui ideo post baptismū filij dei a
pfectione generatōnis i cristo implete ·
repetende a principio natiuitatis huma-
ne potestas pmissa ē: ut requirentibz
demonstraret in quo apprehendēs e-
rat per nathan filiū david introitu re-
currentis i deū generationis admisso ·
indisparabilis dei pdicās in homini-
bus cristū suū · pfecti opus hoīs redire
in se p filiū faceret: qui per david patri
venientibus iter pbebat in cristo. Cui
luce non immerito etiā scribēdorum
actuū apostoloꝝ potestas i ministerio
datur: ut deo in deū pleno et filio pdi-
tionis extincto · oratōne ab apostolis
facta · sorte domini electionis numer⁹
compleretur: sicq; paulus cōsumma-
tionē apostolicis actibz daret · quē diu
cōtra stimulū recalcitrantē dñs elegis-
set. Quod et legentibz ac requirentibz
deū · et si per singula expediri a nobis
utile fuerat: sciens tamē q operantem
agricolā oporteat de suis fructibus e-
dere · vitavim⁹ publicā curiositatem:
ne nō tā volentibz deū demōstrare vide-
remur · quā fastidientibus prodidisse.

Alius prologus

Quoniā quidē multi co-
nati sūt ordinare nar-
rationes q i nobis com-
plete sūt reꝝ · sicut tradi-
derūt nobis q ab initio
ipsi viderūt · et ministri
fuerūt sermonis: visū ē et michi assecuto
omnia a principio diligēter ex ordie abi
scribere optīe theophile: ut cognoscas
eoꝝ verboꝝ de qbz erudit⁹ es veritatē. ca. I.

Fuit in diebus herodis re-
gis iudee sacerdos quidam
nomine zacharias de vi-
ce abia · et uxor illi de filia-
bus aaron: et nomen eius elizabeth.
Erant autem iusti ambo ante deum:
incedentes in omnibus mandatis et
iustificationibus domini sine quere-
la. Et non erat illis filius · eo q es-
set elizabeth sterilis: et ambo proces-
sissent i diebz suis. Factū est autē cū sa-
cerdotio fungeretur zacharias in ordi-
ne vicis sue ante deū: secūdum cōsuetudi-
nem sacerdotij sorte exijt ut incensum
poneret ingressus in templū domini.
Et omīs multitudo ppli erat orās fo-
ris hora incensi. Apparuit autem illi
angelus dñi: stans a dextris altaris

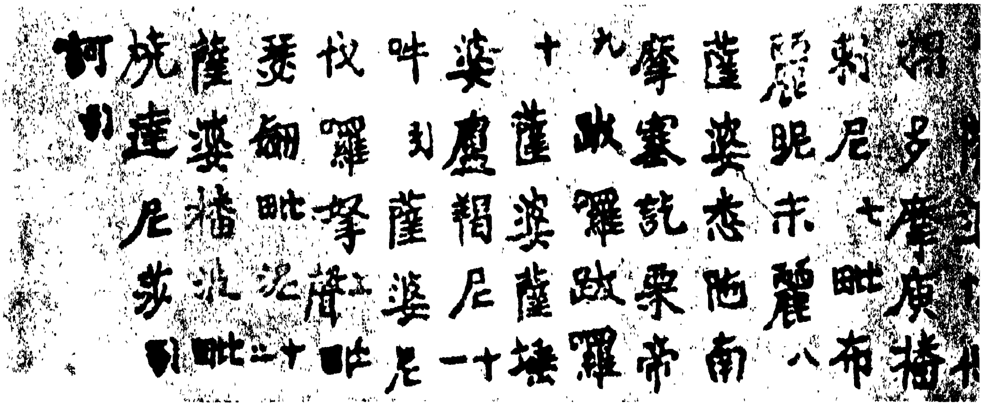
throughout Europe. The speedy and consequent intellectual ferment is an oft-told tale, scarcely worth further comment, if it were not too customary to dwell on the alleged impact on natural knowledge, as on biblical criticism and political theory, of Greek scholarship imported into Europe by Byzantine immigrants in flight from the victorious Turks. The fact is that the positive outcome of Alexandrian mathematics, astronomy, medicine and mechanics had long ago penetrated north-western Europe through visits of students to the Moorish universities in Spain, where positive knowledge had attained a higher level than ever before through the marriage of Alexandrian science to Hindu number-lore. Equally indisputable is the fact that the universities of Toledo, Cordova and Seville were midwives of the cartography which Jewish pilots put at the service of Henry the Navigator. That the new technique of printing made available for the great explorations of the fifteenth century a new scientific amenity for which there was a pre-existing and insistent demand is evident from the mounting number of nautical almanacks published between Gutenberg's first productions and the project of Columbus. Soon there were to follow manuals of military science propounding problems of ballistics created by the introduction of gunpowder into warfare--like paper, from Chinese sources by way of the Moslem world.

Why monks, such as Adelard of Bath, should disguise themselves as Moslems to study in the Moorish universities during the twelfth century is easy to understand. The Church had assumed the responsibilities of the ancient priesthoods as custodians of the calendar, and hence of astronomical lore, when Christianity became the official religion of the Roman Empire. As founders of hospitals in conformity with the beatitude of the sick visitor, they were prohibited from active participation in the advancement of medicine as a science by Papal bulls against dissection of the human body, but on that account the more well-disposed to Jewish missionaries of the Moorish culture, when the latter set up schools of medicine on the campuses of the mediaeval universities. To understand the role of the Jews in making available to Europe the fruits of Greek learning through Arabic translations current in the Moslem world, we have to remember that the Jewish community was literate, or sexually speaking half-literate, by virtue of the obligation on the Jewish parent to bring up the boy-child in the works of the Mosaic Law. To the same circumstance, rather than to suppositious inborn endowments with which some Jews, like their persecutors, are disposed to equip them, we may trace a lop-sided and persistent predilection of the Jewish community for the professions of medicine and law. The Jews attained this dominance when Christendom was largely illiterate; but the social maladjustment resulting from a tradition which began at a time when Jews had no right of access to the soil has played a not negligible role in the pathological manifestations of culture-contact in our own times.

That Ionian scientific speculations exerted a salutary influence on Newtonian science, when the atomic concept invaded modern European thought after the seventeenth-century translations of Gassendi and others, is not open to dispute. Nor need we rob the fugitive scholars of Constantinople of the credit for playing a minor part in this climax off-stage; but the efflorescence of science in the seventeenth century was the immediate consequence of technological advances made in the preceding century, and put into circulation through a commercial undertaking which had to sell science to a reading public of master pilots, mining engineers, artillery commanders and spectacle-makers before naturalistic science had paid its way into university cloisters under a more accommodating *sobriquet* as natural philosophy.

With this overdue obituary on the immigrants from the fall of Constantinople in the year preceding the first dated product of the new printing technique let us leave them; and again get into focus the astonishing speed of its spread in an age when the craft guilds jealously guarded their secrets. Here is a technical revolution of the first magnitude at a time when technical innovations diffused leisurely against menacing obstacles of custom thought and of legal sanctions. As such, its tempo is a challenge to curiosity; and part of the answer to the enigma is that there was already a flourishing craft of printing to take advantage of the economy of movable type, when Gutenberg and Fust began their partnership.

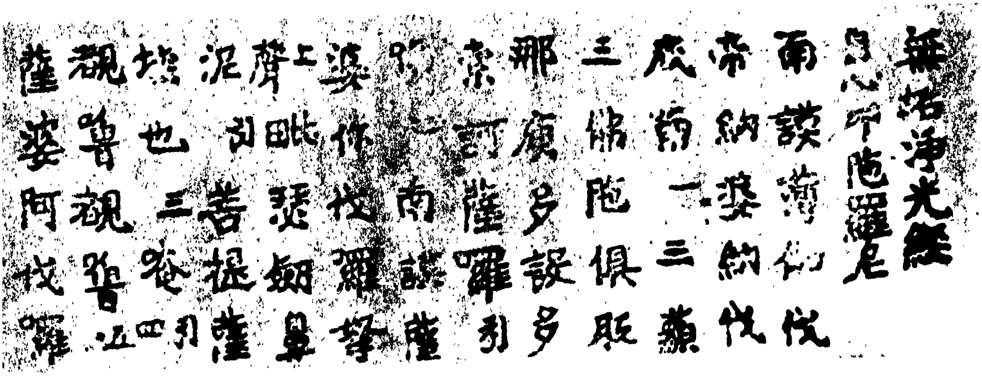
Again, we must pause to pay a debt of gratitude to China, and to civilisations far older than the Chinese. We have seen that the seal is

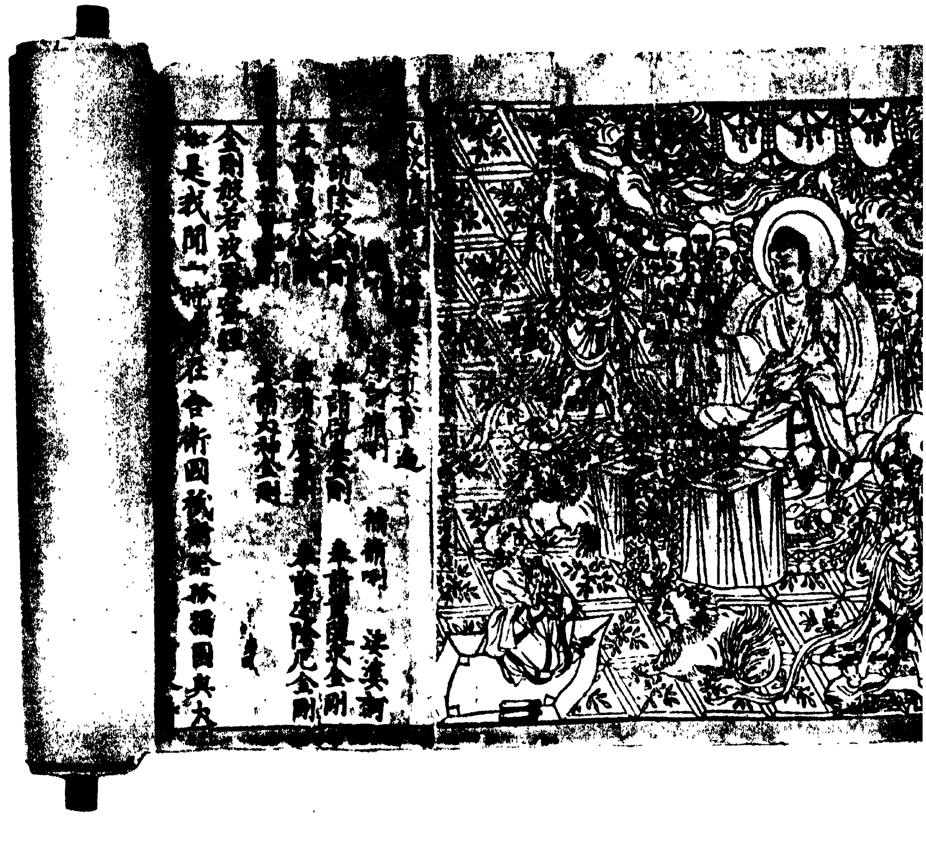


55 The short step from patterns on pottery and silk to block printing on paper was taken in China, probably about A.D. 700. The Buddhist charm (above) is of the T'ang dynasty (A.D. 618-907); opposite is the frontispiece of the Diamond Sutra, earliest known block-print, c. A.D. 868.

the oldest form of signature; and that all our knowledge of one of the earliest literatures of the world comes from clay tablets on which the Sumerian priesthoods engraved their sign-language with a punch to which it owes the characteristic style called cuneiform. The same impulse to impose the signature of a sky-sign on the clay tablet had led men to impress symbols of ownership or good omen on the soft clay products of the potter's wheel before the baking began. A stamp is, after all, a seal to carry a pigment; and the practice of stamping pottery with coloured patterns is of great antiquity. The next step is intelligible in its own territory. In China, whence the silkworm made its lethargic way across the great trade routes of Asia, stamping patterns on silk was probably a practice before the Christian era began; and it was China which produced the first paper. Probably about A.D. 700, though it may well be earlier, the practice of stamping charms by wood blocks on paper began there. In A.D. 767 the Empress Shotoku of Japan ordered a million Buddhist charms to be printed from wood blocks on paper for placing in miniature pagodas.

The Chinese predilection for games such as *Mah Jongg* is an ancient tradition; and an early use of block printing—long before it came into

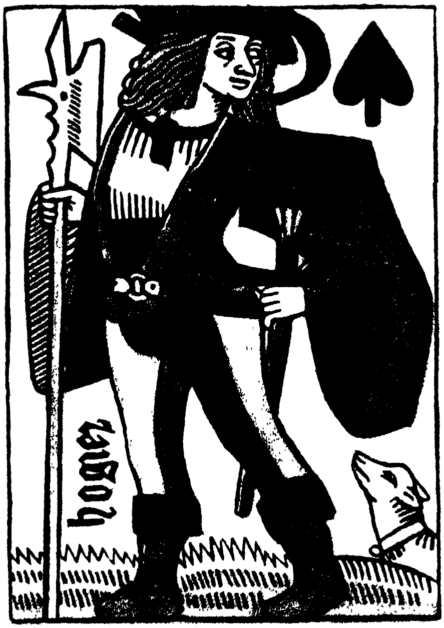

無垢淨光經

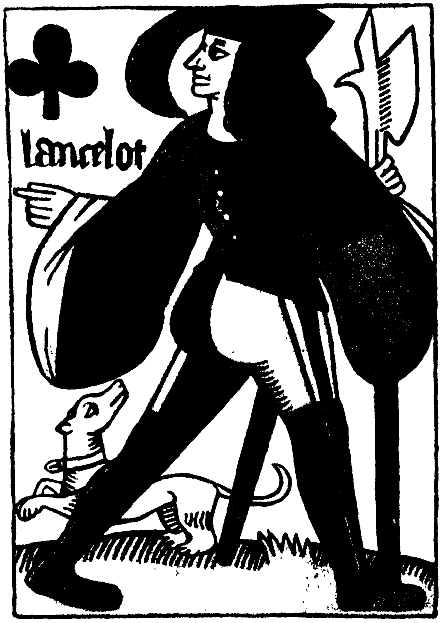

金剛般若波羅蜜經
如是我聞一時佛在舍衛國祇樹給孤獨園與大

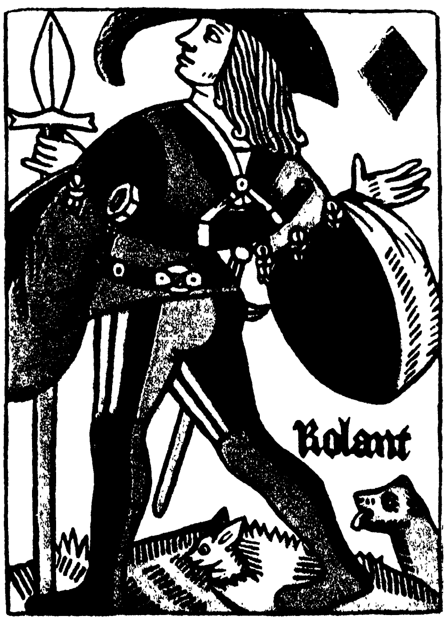
56 *The sheet dice, or playing cards, of China encouraged early block printing. (Right) Eleventh-century Chinese playing card (value three fan) found in Turkestan, probably the oldest known. The Heiligen, or shrine charms, were also printed from wood blocks. (Left) An early fifteenth-century example, portraying St. Florian as protector against fire.*

Europe—is the production of *sheet dice* or, as we should say, playing cards. As charms—pictures of saints—and as playing cards, wood-block printing established a market in Europe at least a century before Gutenberg's Bible. Fortunately, we know some facts about this, as often by a happy dispensation. For the agelong obstruction of the legal mind to progress conspires with its obsessional drive to record its own ineptitudes and thus to perpetuate milestones of progress by the resistance it offers to innovation. Thus we have the record of a prohibition issued by the Provost of Paris in A.D. 1397 against working men playing

V *Playing cards encouraged wood-block printing in Europe at least a century before Gutenberg's Bible. The earliest were wholly pictorial, exhibited the feudal hierarchy and often carried a title or epithet. These fifteenth-century cards, printed in France, were colored by hand.*




lancelot


Rolant


Celum celi domino: terram autem
dedit filiis hominum


is: et pericula inferni inuenerunt me.
ribulacionem & dolorem inueni: &
nomen domini inuocaui

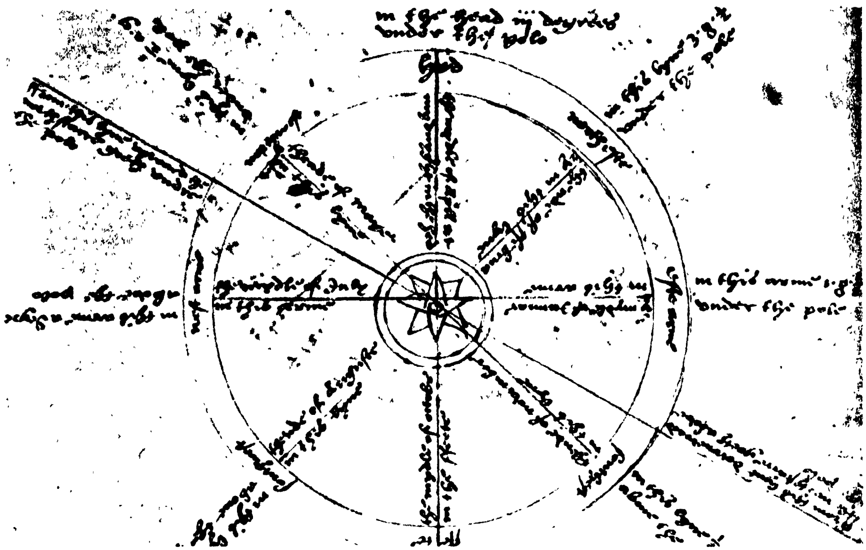
cards on working days; and there were many such prohibitions in German towns about this time. We have also originals of contemporaneous wood-block prints portraying saints for sale at shrines by travelling pedlars and palmers, encouraged to foregather by papal indulgences for the pilgrims.

Like *Snap* and other children's card games of to-day, the first playing cards were wholly pictorial, in suits exhibiting the feudal hierarchy, starting with the king and the queen. The joker is a relic. Sometimes, the wood block of the picture card accommodated a title or epithet, and often the *Heiligen*, or shrine charms promoted by the clergy as an antidote to the carnal indulgence of card-playing, would carry the name of the saint. Either way, the next step was inevitable. We are now in sight of printing as a medium for the rapid circulation of knowledge; but we have to take stock of several features of the folk ways of Europe in the Middle Ages before we take the next hurdle.

When we reach the threshold of the fifteenth century, writing is no longer the prerogative of a priestly caste. There are merchants with big balances in the wool trade, the herring trade and the spice trade. There are pilots who have to rely on their *rutter* books to navigate cargoes of the spice trade over long ocean routes. There is a mounting volume of manorial accountancy and litigation connected with the exchange of produce between the countryside and the boroughs where master-craftsmen and merchants are now aspiring to domestic conveniences heretofore inaccessible to the landed gentry. All this signifies the pre-existence of a considerable semiliterate personnel to provide a market for the products of Gutenberg's trade. It is necessary to say this, because school history too often exhibits the Church and the Law as the custodians of literacy.

What is true is that the monks, and to a less extent the lawyers, were the only people who had time to write *at length* during the century we have now reached. The lawyers we may leave to their own sadistic pursuits. If they have ever contributed anything to human enlightenment the writer would like to hear about it—in Britain, they had not

VI *The tender care with which the monks illuminated their copies of devotional texts established an experiment in visual education. The missals also made block-books possible, and encouraged the invention which was to outsmart them. (Above) Kitchen scene, (below) dinner scene, from the Luttrell Psalter, c. 1340.*



57 *By the fifteenth century, the necessary writing of the merchants and mariners had also prepared a market for the expanding craft of printing. This Tudor diagram, captioned "A Rule for the North Starre", is from Roger Barlos' "Brief Somme of Geographie".*

exchanged the thriftlessness of penmanship for the economy of the typewriter when he had already reached an unripe manhood. The Church deserves kinder consideration, even if the Church has outstayed its welcome. For Catholicism kept alive the lucidity of picture-language in an age when a new technique of illustration offered the only means of grace to the few men who saw the light of science through a miasma of verbal puns.

In short, we are here talking of the *Missals*, a form of sacred art with a charm to which even a hard-boiled technician such as the writer is not entirely indifferent. There is a pathetic earnestness about the tender care with which the monks illuminated their copies of devotional texts, and one which established what we may fairly call the first experiment in visual education for the people. The monks who made the missals offered a helping hand to the new industry. To be sure, we read a lot of rubbish written about what we owe to them; but they did one thing of

58 *The devotional block-books, in which pictures and text were printed from woodcuts (or the text added in manuscript), were possibly the immediate precursors of the type-set book. These two pages are from the first edition of "Ars Moriendi", c. 1450.*

enduring value besides starting hospitals and nursing the spectacle trade for the benefit of "poor blind men". They made *block-books* possible. In the admirable book already cited, this is what McMurtrie has to say about their contribution:

> There is . . . . one exceedingly primitive block book, the *Exercitium super Pater Noster,* in which the illustrations are printed from woodcuts and the text added in manuscript . . . The costume is that of the Burgundian court of the second quarter of the century, and this feature, in conjunction with the technique of design and cutting, led Hind to date the book about 1430 and hardly later than 1440.

There is still argument about whether devotional block-books with both illustrations and text produced from fixed blocks antedated or synchronised with printing from movable type; but it seems fairly certain that block-books were in circulation before the wastefulness of cutting the same letter over and over again on the same block occurred to Gutenberg, and likely enough to many others. The issue is of academic interest only. What we can say certainly is that the printers of playing cards and of *Heiligen* were already involved in the book industry before it occurred to anyone to make punches and dies for letters of the alphabet in order to dispense with the necessity of repeatedly carving the same sign on a com-posite block. Metal-founders of the thirteenth century already knew the art of using stamps with single letters in relief to make an impress on fine sand for molten metal when making inscriptions, themselves to appear in relief on the finished casting. In bell foundries, among craftsmen who made pewter vessels with inscriptions, in the minting of coin and the casting of medals, the use of metal single-letter punches and dies was also commonplace.

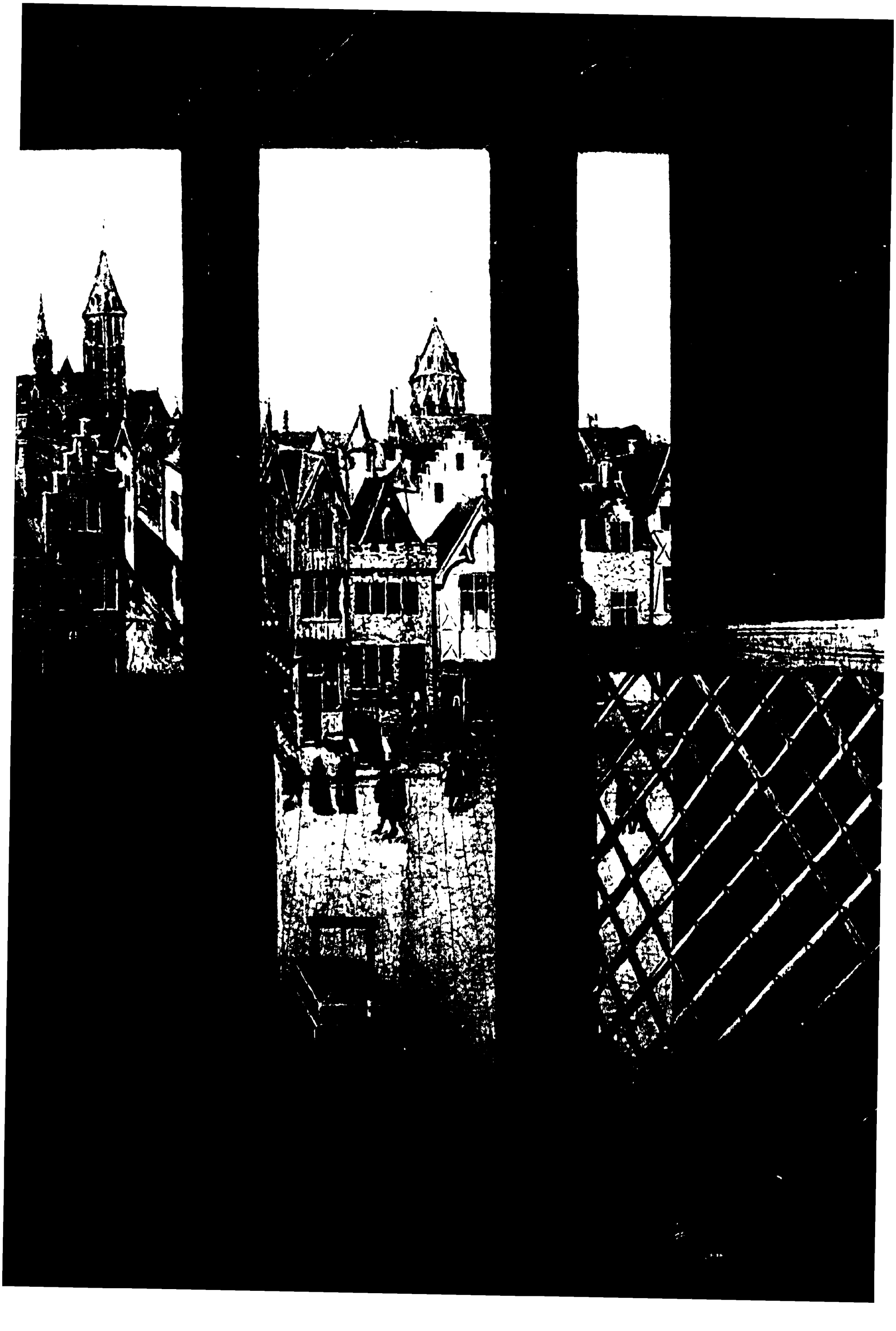
In short, there is already in existence an industry of master printers when the record of Gutenberg's lawsuit bequeathes the first documentary evidence of printing as we use the term to-day—moreover an industry working in close contact with ancillary crafts which had already solved the technical problems on whose solution printing on a larger scale at less cost was attendant. There is a market for books, with richer profits if the printer can solve the technical problem of outsmarting the monks in the art of making the first copy, as he can already outsmart them by reproducing the first copy without limit. In one sense, we now have a press.

Still, we have not explained the phenomenal rapidity with which the new technique of cutting stamps to make up a frame of continuous type spread throughout Europe, unless we look at our period in its social en-tirety; and if we are to do so we must take stock of many things which were not happening in China, the parent civilisation of the printing art. One of them is sufficiently obvious to be easily overlooked in an age of central heating. Europe, as post-war American tourists will agree, is rather cold and rather cloudy. That is why it is important to bring glass into the picture. Glass is an invention of great antiquity, being in fact an early Egyptian amenity; but the very qualities we admire in the iridescent glass of Etruscan or Roman vessels make it equally unsuitable to the uses of domestic life or to the science of gas or temperature measurement.

Before you have leisure to read, in the chilly north of the Hanseatic League or the Flemish wool trade, you must have a technique of house design utterly different from what meets your requirements in the sunny south of Greece and Italy, Crete or Egypt. It is therefore relevant that there is now, in the fifteenth century, a prosperous burgher class with houses equipped with windows made of glass, glass of poor quality by our standards but vastly better fitted to its principal use than the glass of antiquity. Nor is it irrelevant that spectacles are now coming into use for the old folk who have time on their hands.

The very fact that we now have windows brings into focus that we have an emergent class of semiliterate and relatively prosperous merchants and craftsmen, a class which is beginning to send its sons to grammar schools to get a smattering of reading and of the art of cyphers. This consideration prompts reflection upon the almost ubiquitous association of the goldsmith as the patron, partner or financier of the earliest master printers of books. There is now a wealthy craft of jewellers and armourers skilled in the art of using punches and dies to make patterns in relief on a metal surface, with a secure trade among the nobles and the wealthier merchants; and there are already the beginnings of a new trade in pictorial reproduction fostered by artists seeking patrons among them. Before printing by movable type begins, the wood-block illustration is competing with a better technique. Instead of smearing a sticky ink on a raised surface, it is now possible to achieve the same end by filling the crevices in a metal plate wiped clean; and who should be more concerned with promoting the use of pictorial reproduction by engraving than goldsmith and jeweller well versed in the uses of impressing a pattern in relief or intaglio?

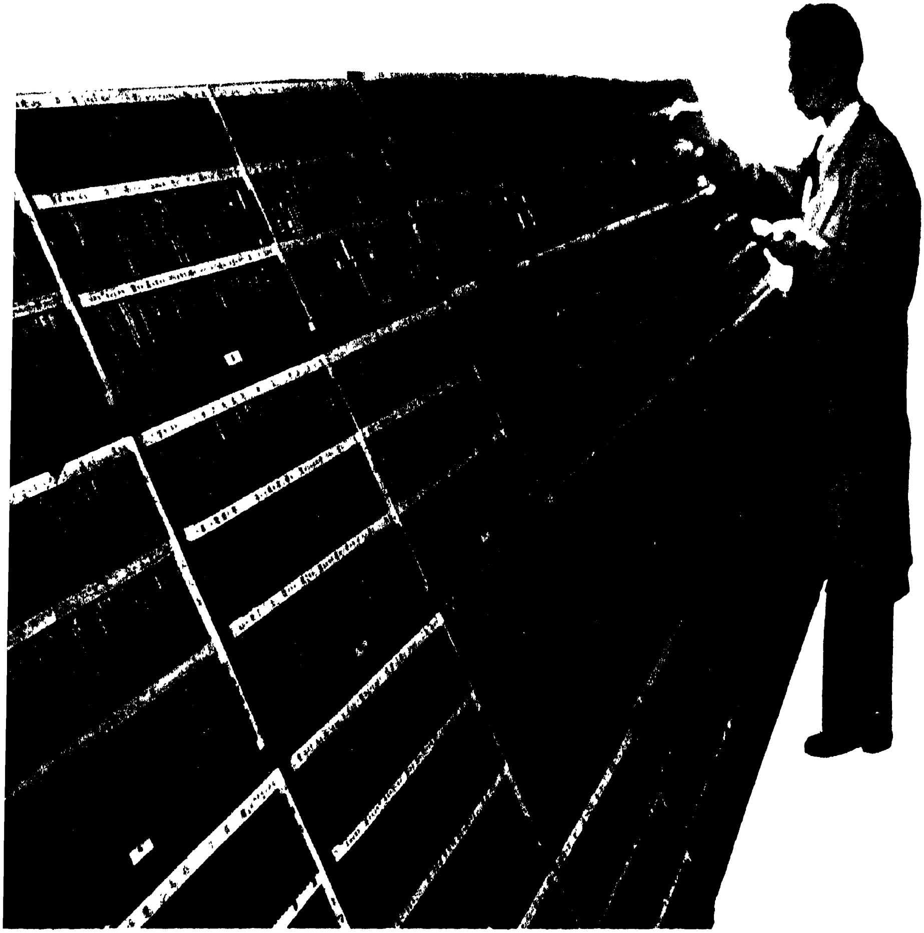
What is happening in the fifteenth century is not the outcropping of inborn genius. Contrariwise, we should regard it as the confluence of a large number of new techniques, individually of little import to human advancement, collectively with a new momentum. Nor need we pride ourselves on the fact that European civilisation proved equal to exploiting to greater advantage what it had thanklessly received from the Eastern world. Paul Pelliot has discovered wooden types attributed to Wang

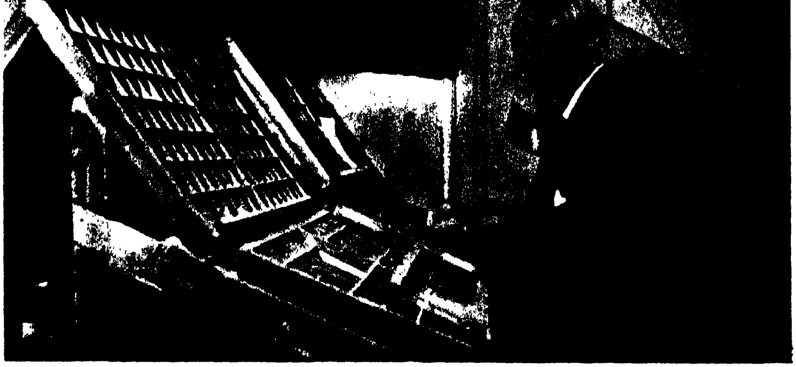


59 Clear glass windows were necessary adjuncts to reading in chilly Northern Europe, as were spectacles for the aged everywhere. In the fifteenth century both were coming into more general use. This detail from the Merode altarpiece, by the Master of Flémalle, c. 1410, shows glassless windows with wooden shutters (left). In 1487, Hans Memling's portrait of Martin van Nieuwenhove showed shuttered windows partly glazed. Hermann tom Ring painted "Virgil with Eye-glasses" in the sixteenth century.

Cheng in the beginning of the fourteenth century, well over a hundred years before the first dated printing from movable type in Germany; and if this invention came to nothing, have we far to seek the explanation? With twenty-six pigeonholes for a box of letter type at his elbow, the European compositor of the fifteenth century enjoys an immeasurable advantage over his fourteenth-century fellow craftsman who has to manipulate several thousand Chinese characters. Korea took up movable type, probably through Chinese influence, about fifty years before Europe.

No intelligent Anglo-American needs to be told at length how printing contributed to the diffusion of knowledge previously transmitted by oral tradition, how much more the master printers and book-makers from Gutenberg to Benjamin Franklin contributed to the making of our language habits than all the professors of their time, how much the trade





in reading matter contributed to the great enlightenment of the four centuries which followed, how it also contributed to the liberation of Christendom from papal authority, what it bestowed on the age of Galileo and Newton, how it catalysed man's thought about human dignity and fundamental human rights. What we are prone to forget is how much water had to pass under the bridges before the homeland of Caxton or that of Franklin could assert the ability to read and to transcribe the written word as the birthright of every citizen.

In North America and in North-Western Europe, literacy is to-day a medical diagnosis. That a person cannot read or write is now a sufficient criterion of mental defect; and this is so in a sense which would have been utterly false of Britain or the United States alike when Charles Dickens wrote an uncharitable record of his transatlantic itinerary. Until the middle of the nineteenth century there was everywhere a large under-privileged class cut off from the possession of books and without the incentive to purchase reading matter. How the incentive came into being will be the theme of a later chapter; and we shall then see the role of the daily press in the final liquidation of illiteracy in our midst. Here our story is the story of paper and printing; and we cannot complete it without a word about a dramatic sequence of technical advances during the century before our own.

By attaching a cast of the hand-set type to cylinders it was possible to take advantage of the introduction of steam power with considerable economy of time entailed in running off the printed sheet; but it was impossible to reap the harvest of this economy while it was still necessary to set type by manual extraction from a box of each die for a letter, cypher or punctuation mark. Also, the manufacture of paper from rag was a relatively costly process by modern standards; and the discovery of a cheaper source of raw material was a precondition of expanding trade in the printed word. Rag, be it said, is simply woven fibre of cotton or flax; and any vegetable fibre is good enough for the work of the wasp.

60 *Wooden types existed in China well over a hundred years before movable type appeared in Germany, but no corresponding expansion of printing followed. The difficulty of the Chinese, with their several thousand characters, is illustrated by this comparison of a Chinese type-case with the two complete upper and lower cases at which the English compositor stands.*

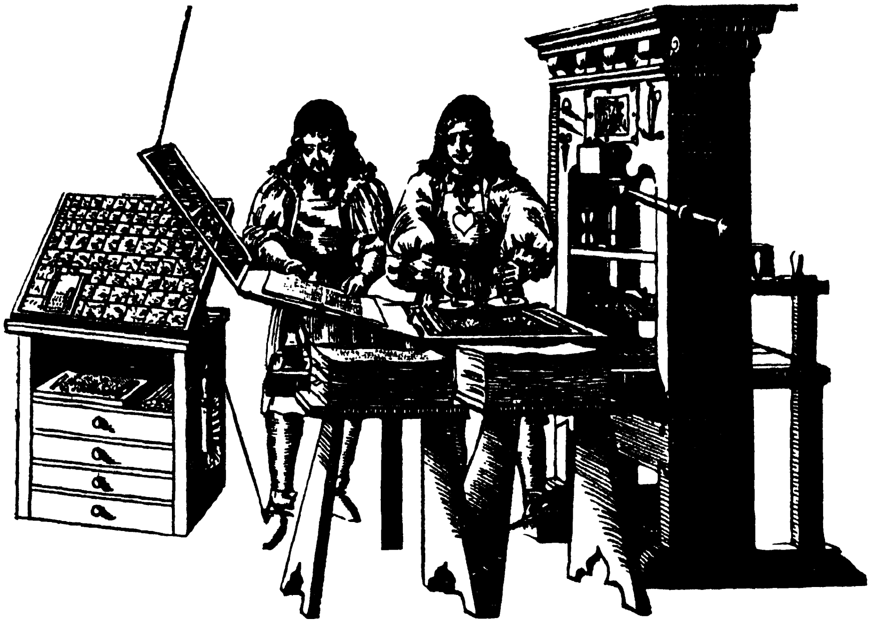
It was therefore a great advance, when it was possible to use the by-products of the lumber camps for paper manufacture. Wood pulp as a source of paper came into its own in the eighties, though its use goes back to a German patent about 1840. In 1857 Routledge had introduced, as an alternative source of raw material, esparto grass from Spain and N. Africa; and there had been notable advances in the mechanics of paper production during the preceding fifty years.

In 1803 the French printer Didot brought into England a device which took advantage of steam power by running wet pulp on to a moving endless belt of wire mesh through which the water drained off. It could run off in a day six miles of paper of uniform width. In 1821 Crompton invented the process of drying by steam-heated rollers. Between 1803 and 1815 König in Germany and Cowper in Britain had perfected power-driven machinery for printing off a continuous roll of paper from cylinders carrying the type cast. The four-cylinder machine patented by Cowper and Applegarth in 1827 ran off 5,000 sheets per hour of the London *Times* simultaneously printed on both sides. The *Walter Rotary* of 1866 appears to have been the first cylinder machine to print on both sides of an unwinding roll of paper with a power-driven mechanism to cut the sheets, previously fed to the machine by hand. By that time a cheaper source of paper was available.

The advent of cheap paper accommodated the purchase of reading matter to the purse of the poorer classes in the community; but it did not bring into their lives a daily stimulus to read. While typesetting remained a manual operation, the maintenance of a daily press was beset by many difficulties and possible only because it did not as yet aspire to the topical immediacy which could coax a large semiliterate section of the population into the habit of daily reading. What made possible a truly popular press was an invention thus described by McMurtrie:

> Setting extensive manuscripts by hand is, of course, a very slow and laborious process, and as the printing industry grew in extent and importance it was only natural that efforts should be made to devise a means of setting type mechanically at greater speed and less cost.

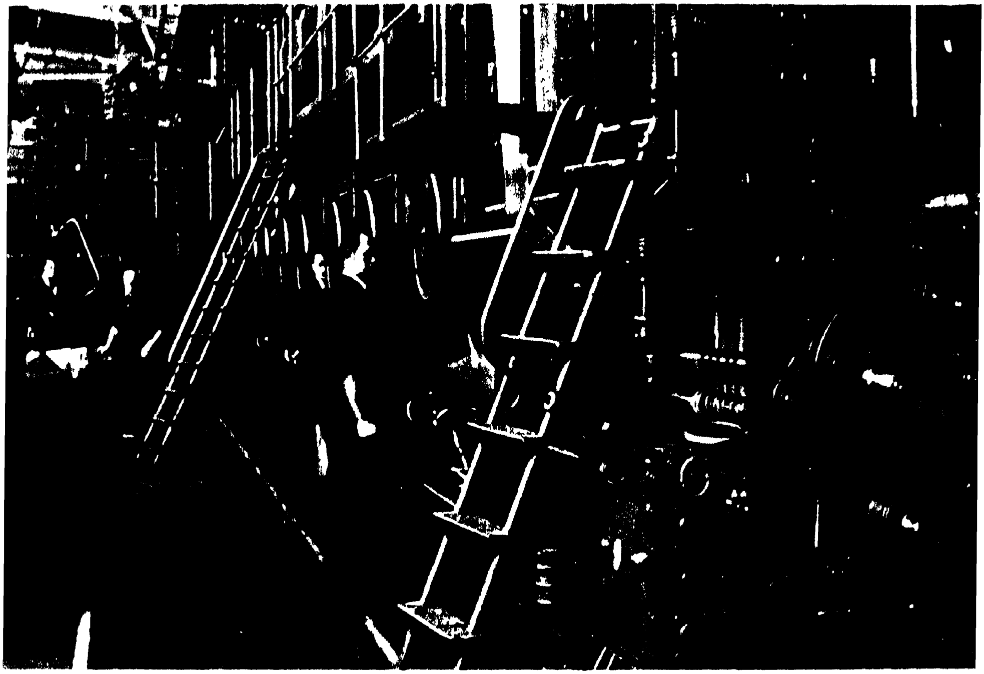
61 It was not until the beginning of the nineteenth century that the mass production of paper, on machines driven by steam, became possible. (Left) Sieving the wet pulp in the hand process, from the "Ständebuch", 1568; (right) modern reel paper ready to feed a rotary machine.



. . . The failures were myriad. All efforts to take the foundry type used by the compositor and set it up mechanically came to naught. Finally, however, Ottmar Mergenthaler invented a machine which, by the action of a keyboard somewhat resembling that of a typewriter, assembled not type but matrices and, when a whole line was set and spaced, cast this line in one piece, or "slug", of type metal. This machine, which was first put into practical use in 1886, and appropriately christened a "linotype", gave a revolutionary impetus to the printing industry. . . . As with all new inventions of importance it was expected that thousands of compositors would be thrown out of work. But, again as usual, the industry grew so fast that more men were employed than before.

This device is not the only machine which sets type. On its heels came the monotype which employs the pianola principle for power transmission and is for some purposes preferable. The technical advantages of one or the other are irrelevant to our theme. What makes printing by linotype an outstanding achievement of nineteenth-century technology is that it permits typesetting to keep pace with the tempo of topical affairs at a time when a railroad schedule co-ordinated by telegraphy has made man minute-conscious for the first time in history. It is at once a new goad to

 the new social discipline of punctuality and a new means of satisfying an



62 *In the nineteenth century, also, came the rapid development of the power printing press. (Left) Early hand-press (from Comenius, Nuremberg, 1666), perhaps 30 sheets per hour; (right) modern multicolor rotary machine, about 20,000 complete magazines per hour.*

appetite for sensation among a section of the population not as yet attuned to habitual reading.

A recent article by C. Lester Walker describes far more drastic innovations which are at present on trial in America, where the book trade and news press have got to grips with a world-wide increase of production costs. Lester Walker cites the following illustrative figures.

> . . . a novel in 1941, 350 pages, 10,000 sales at $2.50, brought the publisher a final profit of about $800. To-day, according to Mr. McIntyre's figures, the same book, but priced at a conservative $2.75, would be likely—if the publisher paid a 15 per cent royalty and made an ample charge for overhead—to net him a $1,500 loss on a sale of 10,000 copies. . . .

The new devices go way beyond the linotype or monotype by eliminating the use of movable type altogether. Instead, they prepare a copy for

63 *A third circumstance which made possible a truly popular press was the machines which enabled typesetting to keep pace with the tempo of topical affairs. An operator at the keyboard of a modern Lino-type machine, which composes and "justifies" a whole line of type.*

photographic etching on a plate which prints off writing as it is customary to print off black-and-white pictures. Prerequisite to the production of the copy itself is a suitable machine for transcribing it. Lester Walker thus describes one such model:

> One of the first to appear on the scene was a machine called the Vari-Typer. This was a kind of glorified typewriter with interchangeable typefaces of 600 sizes and styles, in 50 different languages. Including Arabic! But what it could do especially for printers was to *justify* the lines. That is, it could produce an even right-hand margin, as in a type-set news column.

A recent strike of printers was the occasion for giving this device a try-out on the *Chicago Tribune*. The Vari-Typer, says Lester Walker,

> had been some time on the market, but publishers had fairly consistently given it the brushoff. They had put it to work only once—in 1946 on the Bayonne *Times* of New

Jersey, when the linotypers had struck for one day. But now, in Chicago, it found a spectacular opportunity. . . . They first typed up the story in correct column widths on the Vari-Typer or (case of the *Sun-Times*) on a similar "justifying typewriter" of the International Business Machines Corporation. The columns were then pasted up on cardboard the page size of the newspaper. Headlines were then pasted above. . . . Pictures similarly, alongside. The page filled, it then had its photograph taken.

This "picture" of the page was then . . . acid-etched on a sheet of zinc. Copies were made, put on the press as cylinders, and run. . . . Then another factor, this time a new material, entered the picture with a possible solution. This was the magnesium printing plate. Zinc and copper had always been standard for newspaper printing. Magnesium had been thought of and was being developed by the Dow Chemical Company, but had never taken hold. . . . Two Chicago papers now pounced on it and began experimenting, and magnesium had joined the current revolution. Using magnesium plates, the papers found you could banish the time-lag caused by making engravings. Old-time photo-engraving plates sometimes took over an hour to etch. With magnesium the time from copy to *full-page-size* finished plate was forty-five minutes. The amount of time the old materials took to make one half-tone. And the new material turned out to have revolutionary advantages in another respect, weight: one fourth of zinc, one fifth of copper. The usual stereo weighed forty-six pounds. If magnesium, it weighed nine. . . . If chromium-plated, they were, one publisher had said, "practically eternal".

That the Moslem world of Omar Khayyám and Alkarismi transmitted so many of the benefits of Chinese civilisation to the West, reaping themselves no advantage from the invention of printing, illustrates a truth which Marxist dogma ignores. Fruitful innovation is, as the Marxist rightly asserts, the result of interplay between human needs and natural resources; but the triple formula of means, motive and opportunity suffices to account for the vagaries of man's history only if we recognise the inherent inertia of human motivation. Beliefs do not come from heaven; but they have a remarkable tenacity in the teeth of worldly profit, a tenacity forcefully illustrated by two facets of the Moslem creed. In the racy, though none the less scholarly, account of the history of printing already cited several times in this chapter, McMurtrie states:

The Koran forbade games of chance. . . . The Koran had been given to the Moslems in written form, and writing, therefore, was the only means by which it might ever be transmitted. To this day the Koran has never been printed from type in any Mohammedan country; it is always reproduced by lithography.

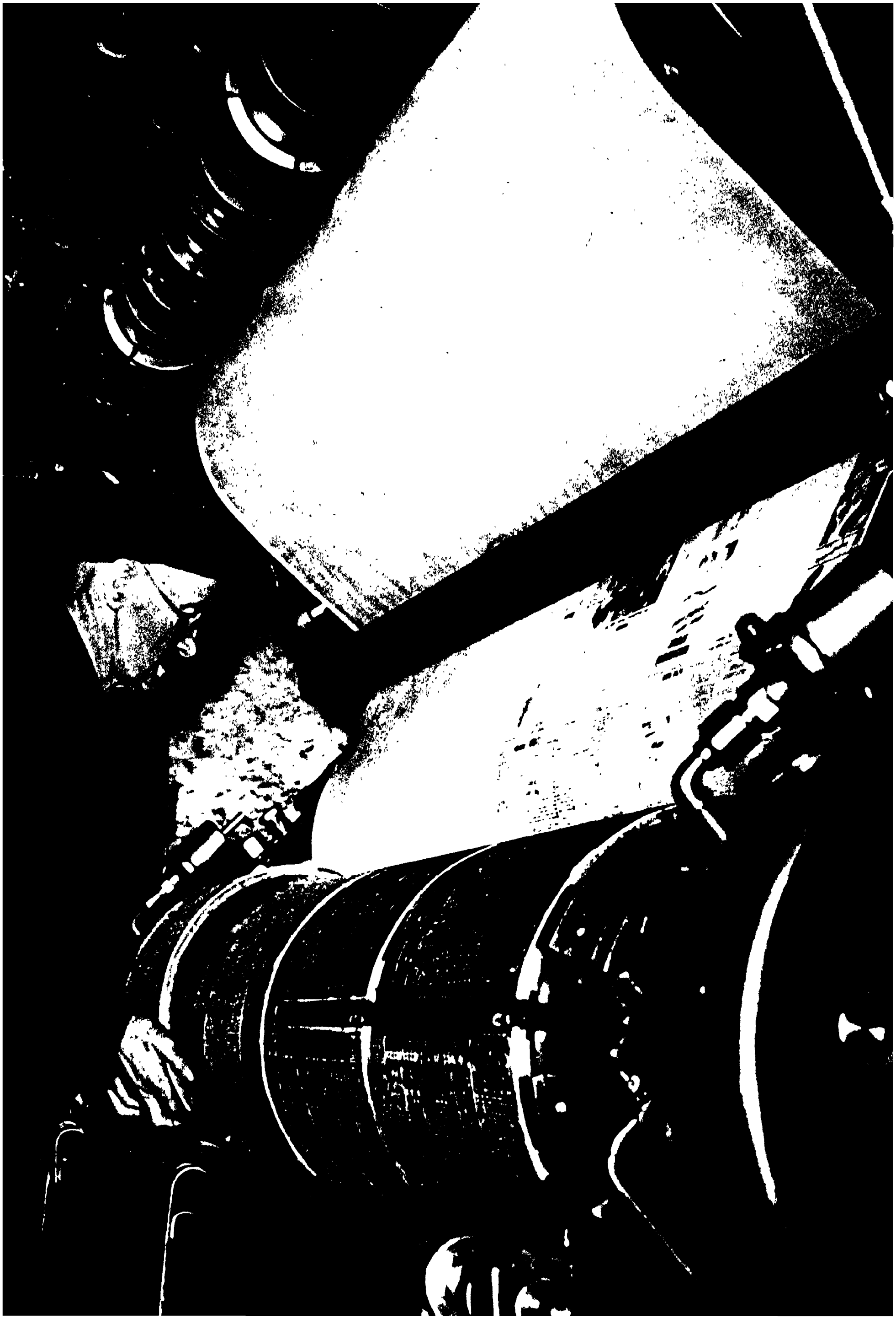
One consequence of this is that Moslem countries, and African com-


بسم الله الرحمن الرحيم
تنزيل الكتاب من الله العزيز الحكيم
إنا أنزلنا إليك الكتاب بالحق فاعبد
الله مخلصا له الدين ألا لله الدين
الخالص والذين اتخذوا من دونه أولياء
ما نعبدهم إلا ليقربونا إلى الله زلفى إن

64 By Moslem law, the Koran could be transmitted only in the written form in which it was given. Printing from movable types was therefore retarded and Moslem education suffers still from the difficult cursive style of this page of the Koran (Moroccan, twelfth–thirteenth century).

munities which have received their script from Moslem missionaries, suffer from the educational disability of a cursive style which is ill-suited to easy reading. If we are tempted to ascribe this to defective hereditary equipment of peoples whose culture was the inspiration of Europe in the Middle Ages, we may well reflect with moral and intellectual benefit to ourselves on the complacency with which western scholars disown the constructive tasks of language-planning at a time when scientific journals embodying new discoveries are appearing in twenty or more languages.

Statistics which convey a clear picture of the mounting volume of printed matter issued annually during the four centuries of European printing are hard to come by. The number of editions printed in England increased from 13 in 1510 to 219 in 1580, to about 600 a year in the first two decades of the nineteenth century and 12,379 in 1913. Unhappily, an edition is a grossly misleading index of production, even of new books. What we call a modern best seller signifies a first edition of over 25,000 copies. In the fifteenth century, the average edition was about 300 copies. Till the middle of the eighteenth an edition rarely exceeded 600; but there were notable exceptions. There were 34 editions of the *Adagia* of Erasmus, each of a thousand copies, in the first few decades of the sixteenth century, and 24,000 copies of his *Colloquia Familiaria* came out in the same author's lifetime. Of Luther's tract *To the Christian Nobility* 4,000 copies were sold within five days. The Bible Society, founded in 1711 by Baron von Canstein in Halle, printed within a short space of time 340,000 copies of the New Testament and 480,000 copies of the Scriptures as a whole. The British and Foreign Bible Society, founded in 1804 by Thomas Charles of Bala as an incident in his crusade against Welsh illiteracy, was responsible for the issue of 237 million copies in the three decades 1900–1930.



FROM CAVE PAINTING TO COMIC STRIP 6

Standardisation, Stereotype and Isotype

In the last chapter our main concern was to get a broad view of technical devices which have contributed to the democratisation of the written word in the western world. So far, we have taken no cognisance of the formative role of the master printer *vis-a-vis* the culture of contemporary western civilisation. We shall now try to get into focus the consequences of something quite new in the history of our species, the emergence of a social personnel with a vested interest in the enlightenment of mankind. Of such was the inventor of the first saleable electrical device, the originator of the very names positive and negative in their now most common technical context, a man who rendered signal service for his country at the court of France and put his signature to the Declaration of Independence, the man whose last will and testament begins "I, Benjamin Franklin, Printer . . ."

At first, the master printer was also a publisher, till the trade began to expand a bookseller as well, and sometimes, like Caxton, translator or author. Nor is it surprising that printing and bookselling still preserve the professional outlook of the mediaeval craftsman far more than any other contemporary commercial undertaking, with *morés* peculiar to themselves. To-day, as throughout the past four centuries, there is still a place for the small-scale high-quality firm in printing, publishing or bookselling alike. Throughout the five centuries of printing from movable type the small proprietor has ever been the ally of novel thought; and the book trade still thrives on the free expression of views which are anathema to big business, oil politicians and Wall Street tycoons. To say this is not to say that every publisher, every partner in a printing firm or every back-street bookseller is in the vanguard of liberal sentiment and fertile cere-

65 *By the very fact that it could reproduce large numbers of copies from the same type, printing standardised spelling and grammatical conventions. Stereotype plates, revolving on the cylinders of a modern press, will reel off thousands of identical printed pages.*

In these two bokes precedente. we haue by the helpe of god tretyde of the two first destruccyons of Troye. with the noble faytes and dedes of the stronge and puissant Hercules. that made and dyde so many merueyllis that the engyne humayn of alle men oughte to meruaylle. And also how he slewe the kynge Laomedon bete doun and put his cyte of troye to ruyne Now in the thirde and laste book god to fore. we shall saie how the sayd cyte was by Priamus sone of the saide kynge laomedon reedified and repayred more stronge and more puyssante than euer hit was before. And afterwarde how for the rauysshement of dame helayne wyf of kynge Menelaus of grece. the sayd cyte was totally destroyed Priamus hector and alle his sones slayn with noblesse wyth out nombre. as hit shall apper in the proces of the chapitres..

How the kynge Priant reedified the cyte of troye more stronge than euer hit was afore and of his sones and doughters. And how after many counceylles he sente Anthenor and Polydamas in to grece for to redemande his suster exione that Ayax mayntened.

FOR to entre than in to the matere. ye haue herd here to fore at the seconde destruccion of Troye how hercules hade taken prysonner Priamus ye sone of kynge Laomedon. And had put hym in prison. how be hit dares of frigie sayth yt his fader had sente hym to make warre in a strange bration; but to be blind to their contribution to our common culture is to be blind to one of the burning issues of our age. Even to say that the publisher, the printer and the bookseller is always ahead of his business colleagues in joining the band wagon of progress is to dispel a miasma of moral indignation which distorts our view of a decision contemporary man has to make wisely or incur the prospect of a dark age of superstition and authority.

Our new theme has therefore a peculiar relevance to the political animosities of the post-war world and a special bearing on the constructive tasks of unifying mankind. There are still among us, and especially in America, political adolescents who choose to view the dilemma of modern man on the threshold of the Atomic era as a black-and-white choice between private enterprise and government interference. There is in fact no such motion on the agenda. What St. Augustine said of the City of God is true of the collectivist case. *Petant aut non petant venire habet.* Freely translated, that means: you will take it, and you may as well like it. For nothing is more certain than the inevitability of increasing intervention of government in large-scale enterprise, and few things are more certain than the corruptibility of a bureaucracy undisciplined by instruments of free criticism they cannot control.

The cardinal choice of to-day is not between the American way of life and the Soviet creed. At the political level, the liberal onlooker can see little to choose between the exploits of the Congressional Committee on un-American activities and the purges of the Police State. Even the fact that the United States can still boast, as the Soviet Union cannot boast, of its free press signifies all too little while the American law of libel gives no protection against moral annihilation to the author. The real choice before us is between monolithic communism and a new way of life which is coming to birth in Britain, where courageous experimentation in public enterprise goes hand in hand with an all-party determination to preserve the book trade as an instrument outside the framework of govern-

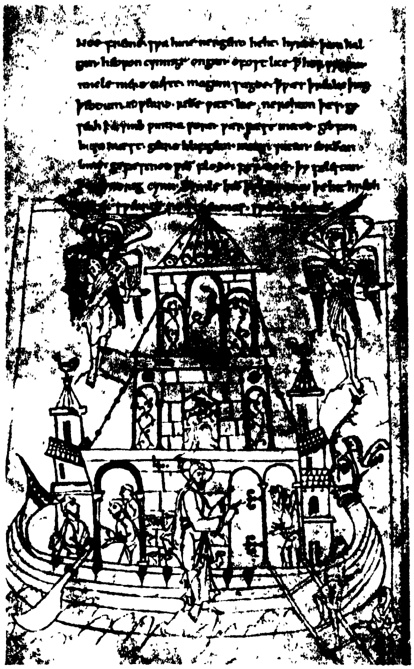
66 *William Caxton's "Recuyell of the Histories of Troye", translated from the French between 1469 and 1471, was printed about 1475. As master printer, author, translator, publisher and bookseller Caxton was the first of a line of craftsmen whose tradition persists, in a book trade which still thrives on the free expression of novel thought and opinion.*

ment control. Britain will have overpaid her dues for Marshall Aid, when Americans realise what the new British way of life means.

The Marxist theologian will here say that the choice is unreal because all business tends to monopoly in the long run. Needless to say, any sociological postulate admitting of no conceivable exception is merely dogma, as such not even consistent with the emphasis of both Marx and Engels on the propriety of examining the specific qualitative elements of any real situation. All the available evidence contraindicates the likelihood that publishing, printing and bookselling on a small scale will disappear in the immediate future. It is an essential feature of book production that standardisation by large-scale enterprise defeats its own end by failing to satisfy an educated public appetite for novelty and variety. That the film industry offers little scope for the small man is irrelevant and immaterial. It does so for reasons which do not apply to book production. One is that there was no established tradition of educated taste in films when Los Angeles became a financier's paradise. The other is that the relation of printing and binding cost to book content is totally different from the relation of film production cost to the scenic set-up.

The formative influence of the master printer both on the structure of the vernacular and on the study of the living language, in contradistinction to that of dead ones, was immediate and in the long run immense. The mediaeval scribe like the stenographer of to-day was prone to use his own conventions, especially when immigrant in a community with sounds foreign to his native land. So it was that Norman scribes adopted the bogus *Y* in *Ye Olde Tea Shoppe* for the Teutonic sound represented in Icelandic and Faeroese by a new symbol ð, which we ourselves represent by *th* ambiguously for the soft (so-called *voiced*) sound as in *th*ey as well as for the hard (so-called *voiceless*) sound, for which Icelandic retains the old Teutonic þ, in *th*ick. Printing set a uniform standard of spelling by the very fact that it could reproduce vast numbers of copies from the same type. The master printer was *ipso facto* the dictator of spelling conventions.

In one way, the standardisation of spelling was all to the good; but it had a less salutary consequence of which neither the printer nor the scholar of the time had any prevision. The parent languages of what is



Forustugrein

Forðæmi Norðmanna.

r 1949 — 40. tbl.

Horfur nú eitthvað vænlegri um friðarsamninga við Austurríki

Júgóslavía sögð reiðubúin að slaka nokk uð á landa- og skaðabótakröfum sínum.

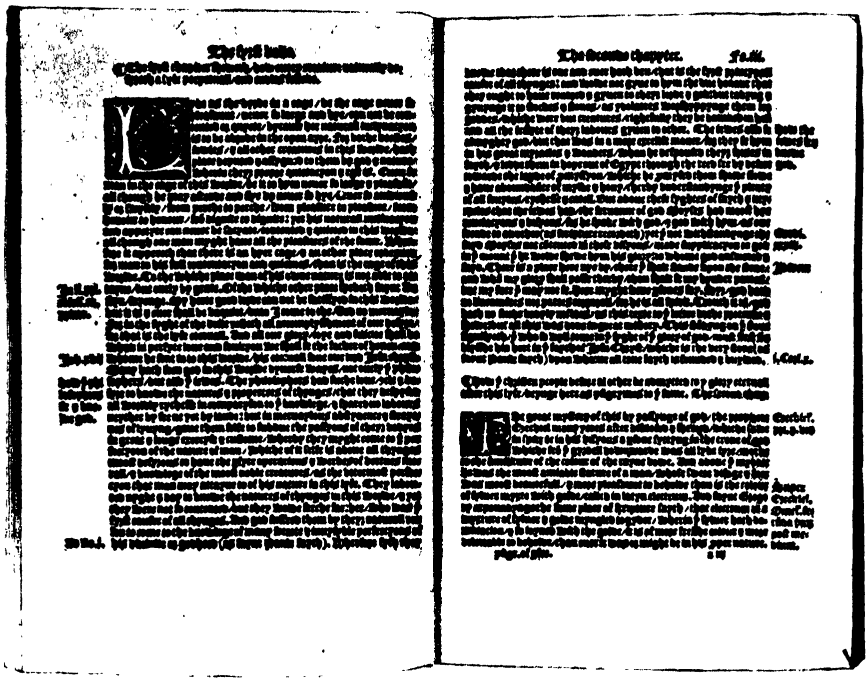
VÆNLEGRI HORFUR virðast nú á því, að einhver skrið ur komzt á viðræður fjórveldanna, Bandaríkjanna, Bre lands, Frakklands og Rússlands, í London um friðarsamninga við Austurríki.

Var í þessu sambandi frá því skýrt í fregn frá London í gærkveldi, að stjórn Júgóslavíu væri talin tilleiðanleg að falla frá landakröfum á hendur Austurríki og slaka á kröfum um um stríðsskaðabætur. Hefur Júgóslavía áður gert tilkall til héraðsins Kärnten, en mun nú ljá máls á að falla frá þeirri kröfu, ef Austurríki veiti slóvensku héruðunum í Kärnten sjálfsstjórn. Stjórn Austurríkis hefur þó lýst yfir því, að hún muni ekki fallast á slíkt samkomulag við stjórn Júgóslavíu.

Í sambandi við fréttina um

67 *Mediaeval writers used their own spelling conventions. Norman scribes introduced the bogus Y for the voiced sound represented ambiguously to-day by 'th'. The Saxon of Caedmon (left) had the two symbols ð (voiced) and þ (voiceless) which survive in modern Icelandic (right).*

predominantly the speech of Western Europe to-day—Latin and old Teutonic—were highly inflected, as is modern standard German. Towards the end of the Middle Ages, they had split up into many local dialects with an accompanying and considerable simplification of grammatical structure. This simplification had still further to go, when printing fixed a standard of word-form which has preserved in writing a load of grammatical ballast which the living language has since cast overboard in its upward ascent. Thus contemporary writing abounds with relics of fossil grammar, and there is a double disadvantage in this. Spelling of the home language reflects habits of speech no longer current; and the



68 Standardisation was not sudden. The "Pilgrimage of Perfection" printed by Wynkyn de Worde in 1531 (above) shows such inconsistencies as 'chapiter' and 'chapyter', 'the' and 'ÿ'. In the page of Shake-speare (opposite) printed in 1723, inconsistencies disappear, but the archaic 'repleat' and 'dazled' remain.

task of learning a foreign language is complicated by the necessity of memorising grammatical rules with no existence outside the paper domain. We spell *dismissed,* which we pronounce as *dismist,* because the *-ed* terminal of the past tense or participle of the English weak verb in the time of Caxton was still vocal as in *beloved.* French has a fantastic incubus of paper grammar of this sort. On the written page, the present tense of the verb *parler* has the five distinct forms *parle, parles, parle, parlons, parlez, parlent.* In fact, only three are now recognisably different to the ear.

To assess this effect of the printer's influence on the structure of language, it is also necessary to remember that nationalism was in its infancy when

The FIRST PART of
King *HENRY* VI.

ACT I. SCENE I.

Dead March. Enter the Funeral of King Henry *the Fifth, attended on by the Duke of* Bedford, *Regent of* France; *the Duke of* Gloucester, *Protector; the Duke of* Exeter, *and the Earl of* Warwick, *the Bishop of* Winchester, *and the Duke of* Somerset.

BEDFORD.

HUNG be the heav'ns with black, yield day to night!
Comets, importing change of times and states,
Brandish your crystal tresses in the sky,
And with them scourge the bad revolting stars
That have consented unto *Henry*'s death!
Henry the Fifth, too famous to live long!
England ne'er lost a King of so much worth.

Glou. England ne'er had a King until his time:
Virtue he had, deserving to command.
His brandish'd sword did blind men with its beams;
His arms spread wider than a Dragon's wings;
His sparkling eyes repleat with awful fire
More dazled and drove back his enemies
Than mid-day sun fierce bent against their faces.

What

printing began in a big way; and any sort of higher education then available was aloof from the life of the common man. There was no recognised standard of educated speech in countries where a multiplicity of dialects were locally current, when the master printer, often also the translator, always had the last word on composition and hence had to decide what current usage to condone or to discard. One illustration will suffice to make this clear. English dialects current in Caxton's time severally favoured the Scandinavian *egg* and the German alternative *ei* in which the *g*-sound is lacking, as in our word *eye*, the English equivalent of the German word *auge*. A quite arbitrary decision of the master printer dictated *egg* as the standard, henceforward correct, usage. That scholars steeped in classical erudition shaped the fusion of the three main dialects of English with a predominantly Middle Kingdom bias is a conceit of the cloister with little foundation in fact. Standard English was manufactured in sheets by craftsmen with a culture consonant with the realities of everyday life.

A dilemma of the German printers exhibits a noteworthy—and deplorable—example of this necessity to arbitrate on the conflicting claims of local dialects. That there is nowhere in Western Europe a sharper dichotomy between familiar speech and writing, in consequence of the adoption of an arbitrary standard, has indeed been no trifling obstacle to the emergence of a democratic culture and a by no means trivial circumstance contributing to the pathological manifestations of cultural nationalism in modern Germany. The background of the story, as Dr. Bodmer tells it in *The Loom of Language*, is a split between two main groups of dialects within the territory where the writ of the Holy Roman Empire ran before the Netherlands won national independence:

> As we go north and north-west, the typical High German sounds fade out and disappear in the plains. The Low German of north and north-east Germany, like Dutch and Flemish which are really Low German dialects with their own spelling rules, remains true to the earlier Germanic sound-pattern. A line across Germany divides a region where Low German forms predominate from one where the High German prevail. It runs from the Belgian frontier south of Aachen to Düsseldorf, thence to Cassel, striking the Elbe above Magdeburg, passes north of Luther's Wittenberg, and touches the Polish frontier

north-east of Frankfort-on-the-Oder. North of the line we hear *dat Water*, South of it, *das Wasser*.

Bodmer goes on to explain how it is that standard German staggers under a load of paper-made grammar which English discarded in the century before Chaucer:

> It is easy to understand why Icelanders can still read the Sagas. The Norse community in Iceland has been isolated from foreign invasion and intimate trade contacts with the outside world, while the speech-habits of Britain and some parts of Europe have been eroded by conquest and commerce. The conservative character of German is not such a simple story. The Hanseatic ports once held leadership in maritime trade. There were famous culture centres such as Nuremberg, Augsburg and Mainz. There was the flourishing mining industry of South Germany and Saxony. There were the great international banking-houses of the Fugger and Welser. Still, Germany was not yet a nation like fourteenth-century England or sixteenth-century France. It had no metropolis comparable to London, Paris, Rome, or Madrid. . . . Till the present generation German was not the language of a single political unit in the sense that Icelandic has been for a thousand years. When Napoleon's campaigns brought about the downfall of the Holy Roman Empire, German was the common literary medium of a loose confederation of sovereign states with no common standard of speech. Modern Germany as a political unity begins after the battle of Sedan. . . . In the fourteenth century, that is to say about the time when English became the official language of the English judiciary, the secretariat of the chancelleries of the Holy Roman Empire gave up the use of Latin. They started to write in German. The royal chancellery of Prague set the fashion, and the court of the Elector of Saxony fell into step. This administrative German, a language with archaic features like that of our own law courts, was the only common standard when the task of translating the Bible brought Luther face to face with a medley of local dialects. 'I speak', he tells us, 'according to the usage of the Saxon chancellery which is followed by all the princes and kings of Germany. All the imperial cities, all the courts of princes, write according to the usage of the Saxon chancellery which is that of my own prince.'

The climax of Bodmer's narrative brings us up to our own time:

> Luther's Bible made this archaic German the printed and written language of the Protestant states, north and south. At first, the Catholic countries resisted. In time they also adopted the same standard. Its spread received much help from the printers who had a material interest in using spelling and grammatical forms free from all too obvious provincialisms. By the middle of the eighteenth century Germany already had a standardized literary and written language. During the nineteenth century what had begun as a paper language also came to be a spoken language.

The contribution of the master printers to a standard of acceptable dialect, correct spelling and grammatical propriety does not circumscribe their formative influence on the evolution of European languages. When German printers sought their fortunes across the frontiers of the Holy Roman Empire they could not impose their own standards of linguistic good taste. In Baltic and Balkan countries the effect of printing was therefore a national revival, first of language and then of literature. Unwittingly, immigrant German printers provided other nations with the means of defending their literary independence. The Lithuanian, Latvian and Estonian languages might otherwise have been absorbed by German in the course of the next century, as was the language of the Prussians, of the Pomeranians and of other tribes before them, because they had not been preserved in print. The survival of Welsh is largely due to printing. From 1546 books were printed in Cymric and thus a literary language was kept alive. Contrariwise, Cornish has become extinct because of the lack of a printed literature. Basque, a relic of Old Iberian, was fixed in print since 1545 despite the predominance of Spanish. The Catalan dialect probably survived because the first printers settled in Catalonia and not in Spain proper. In Italy the Tuscan tongue of Annibale Caro's *Lettere Familiari* (1572–75) was the one finally adopted by the printers, and so superseded other dialects of the time.

The colonisation of the New World, starting fifty years after the first book production by movable type, gave an incentive to a new sort of humanistic scholarship. Its main influence on the study of language in the first century after the beginnings of printing had been to spread the knowledge of Greek and hence to promote a *genre* of biblical scholarship inimical to papal authority. An event which occurred before the first centenary of the Gutenberg Indulgence initiated a new interest in living languages, and it would scarcely be too much to say that it dates the birth of comparative linguistics. McMurtrie tells us:

> In 1539, at a time when printing had not yet found its way into a number of European cities of considerable importance, a printer and his assistants made the long and perilous voyage across the Atlantic to the viceroyalty of New Spain and there began to print in the city of Mexico. . . . The motive in establishing the press in Mexico was predominantly religious—a motive which in many other instances has sent a printer forth to follow close


Euangelion Sanct Matthes. I.
Das erst Capitel.
Dis ist das buch von der gepurt Ihesu Christi der do ist ein son Dauids des sons Abraham.
Abraham hat geporn den Isaac.
Isaac hatt geporn den Jacob.
Jacob hatt geporn den Juda vnnd seyne bruder.
Juda hat geporn den Phares vnnd den Saram von der Thamar.
Phares hat geporn den Esrom.
Esrom hat geporn den Ram.
Ram hat geporn den Aminadab.
Aminadab hatt geporn den Nahasson.
Nahasson hatt geporn den Salma.
Salma hat geporn den Boas von der Rahab.
Boas hat geporn den Obed von der Ruth.
Obed hat geporn den Jesse.
Jesse hatt geporn den konig Dauid.

69 *Printing often retained or imposed much paper grammar which the spoken tongue would not have preserved. Luther's Bible made the stiff, administrative German of the Saxon chancellery the written, and in time the spoken, language of all Germany. (From the first published Luther translation, 1522.)*

on the steps of the explorer. The archbishop wished to have books in the native languages for the use of priests and missionaries, and the function of the first printer in the New World was to print devotional books for the instruction of the natives in the Christian religion.

We now pass the ball to Dr. Bodmer:

Christian salvation was an act of faith. To understand the new religion the heathen must needs hear the Gospel in their own vernaculars. So proselytizing went hand in hand with translating. At an early date, Christian scholars translated the Gospels into Syriac, Coptic, and Armenian. The Bible is the beginning of Slavonic literature, and the translation of the New Testament by the West Gothic Bishop, Ulfilas, is the oldest Germanic document extant. Even to-day the Christian impulse to translate remains unabated. Our Bible Societies have carried out pioneer work in the study of African and Polynesian dialects.

In the age of the Great Navigators, mercantile venture no less than

[illegible]

... en lengua anglesa ...
... sia fins que ...
gar la giras en lengua portogue-
sa opinat per yo esser stat algun
temps en la illa de anglaterra e
gues millor saber aquella lengua
q altri. Les quals paraules son sta-
des ami molt acceptables singular-
ment. Car la yo sia per mon ...
obligat manifestar los actes virtu-
osos dels cavallers passats maior-
ment com en lo dit tractat sia mol-
stesament lo mes de tot lo dret e
orde de armes e de cavalleria. E
certa considerada ma insufficiencia
e los curials e familiars occupaci-
ons qui obstan e les adversitats de
la noyble fortuna qui no donen re-

Decimo certamen.

EN este decimo certamen en que se pide vn Romance en Vascuéce, se juzgò deuerse el primer lugar a Don Pedro de Ezcurra, y juntaméte el premio, que son tres varas de tafetan.

Aldarêco gorpûtç Sanduâri.

IAquiteâ yçâm bânu,
borondâtea beçalâ,
ênc anâya erranennîçu,
nór daucàgum mayean:
Ceruetâ co jâuna dûgo,
gôgor jâusten çaigunâ:
çêruan becâyn ôlo dâgo,

gure-

Johan Waley y printer yn danfon annerch at popol Kymry.

Weswch karedigon Gymry mi ddoetha ac a printais hydic niser o ryw lyfreu hyn wrth ddeissyf gwr bonhedic och gwlad yr hwn i dystolaythei i mi y basswn chwi yn moch chwyddoon dargenwyr mor hynaws gyfeddachwyr ac moch bonheddigaidd awch kyuellach ac y bythei diedifarus ym a gymerets o boen a thrauael a chost yn awch plett: yr hyn o phroswch yn gyfagos i wir, gwy-byddwch y kymeraf amser arall angwanet o lafur mewn fulwt pethau or eiddo wch er awch mwyn: Eithyr yn awr ni chefeis o eithyd punto pop gair kyn ddifeted na chyn gywired ac y mynysswn herwydd paam od gwelaf y gallwyf bod ynbyfempl digolled o ymarfer o brinto ywch: ef bydd diwetarh a dieſbeuſussach pop rhan om gorchwyl y waith nessaf a dew or blayn yr hwn ach battwo ar i lwybyr ef yn wastadawl.
poet gwir.

Imprynted at London in
Foster lane, by me
John Waley.
(1547.)
Cum priuilegio ad imprimendum solum.
( )

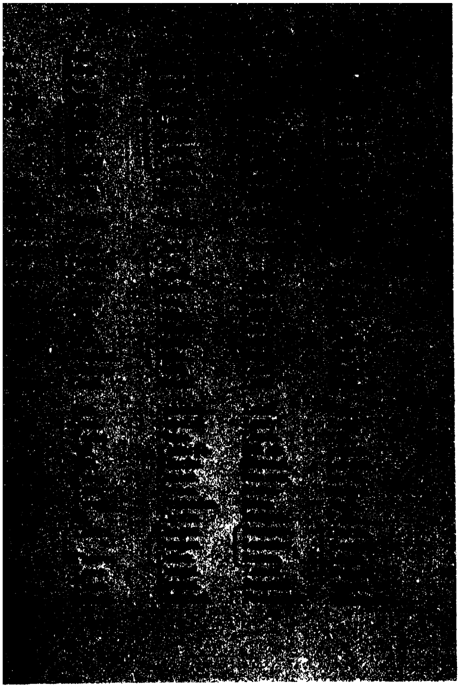
missionary enterprise created a demand for a new sort of scholarship, and encouraged scholars to study the natural history of the living language. "For the first time", says Bodmer,

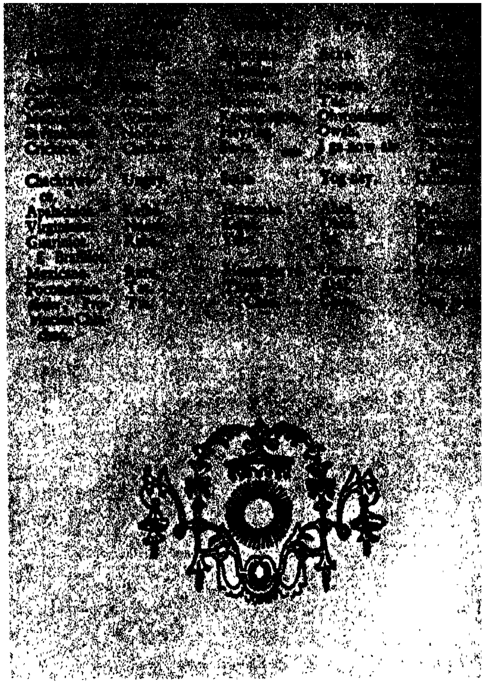
> they began to recognize that some languages are more alike than others. Joseph Justus Scaliger (1540–1609), variously recognized as *the phoenix of Europe, the light of the world, the bottomless pit of knowledge*, saw as much, and a little more, when he wrote his treatise on the languages of Europe. He arranged them all in eleven main classes, which fall again into four major and seven minor ones. The four major classes. . . . Latin (Romance) languages, Greek, Germanic, and Slavonic. The remaining seven classes are made up of Epirotic or Albanian, Tartar, Hungarian, Finnic, Irish (*that part of it which to-day is spoken in the mountainous regions of Scotland*, i.e. Gaelic), Old British, as spoken in Wales and Brittany, and finally Cantabrian or Basque. During the seventeenth century many miscellanies of foreign languages, like the herbals and bestiaries of the time, came off the printing presses of European countries. The most ambitious of them all was the outcome of a project of Leibniz, the mathematician, who was assisted by Catherine II of Russia. The material was handed over to the German traveller, Pallas, for classification. The results of his labour appeared in 1787 under the title *Linguarum Totius Orbis Vocabularia Comparativa*. . . . The number of words on the list circulated was 285, and the number of languages covered was 200, of which 149 were Asiatic and 51 European. In a later edition, this number was considerably increased by the addition of African and of Amer-Indian dialects from the New World.

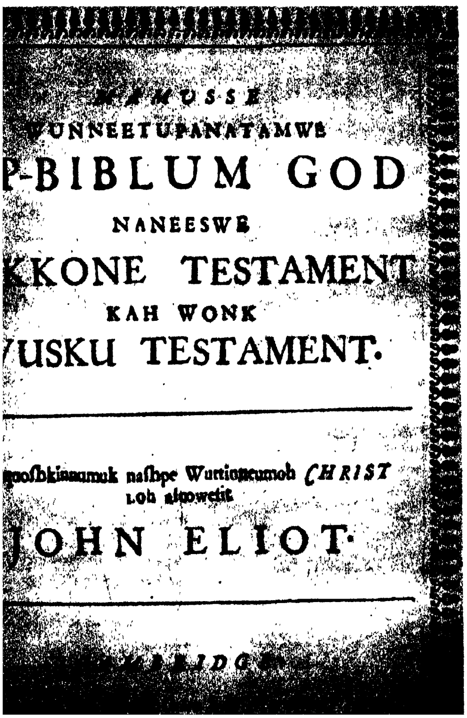
Long before this, the output of grammar books from the printing press was providing a wealth of new species to classify. In 1571 the publication of Otfried's ninth-century *Evangelien-Harmonie* made Old High German accessible. In 1589 Busbecq wrote of the relics of Gothic in the Crimea. Extracts of the Gothic Bible at Upsala were published eight years later. A Dalmatian grammar appeared in 1604, to be followed by grammars of Turkish in 1612, Estonian in 1637, modern Greek in 1638, Danish and Lappish in 1640, and Icelandic in 1683.

We have spoken of the way in which printing *stereotyped* language; and we may here remind ourselves that the expression is a metaphorical usage more closely connected with the standardisation of symbols. Before it was possible to take full advantage of the advent of steam power to print sheets from cylinders, it was necessary to intercalate a new step after

70 *Several of the lesser European languages were kept alive which without a printed literature might have become extinct. (Left) Part of a page from a Catalan romance, 1490; (above) part of a Basque poem, 1609; (below) imprint of William Salesbury's English-Welsh Dictionary, 1547.*

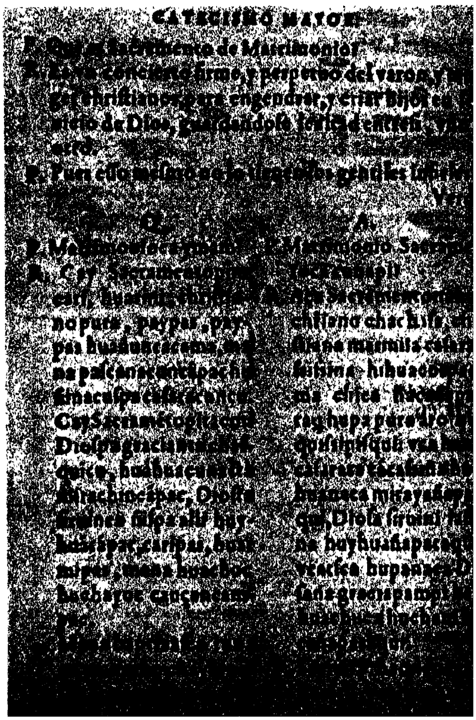






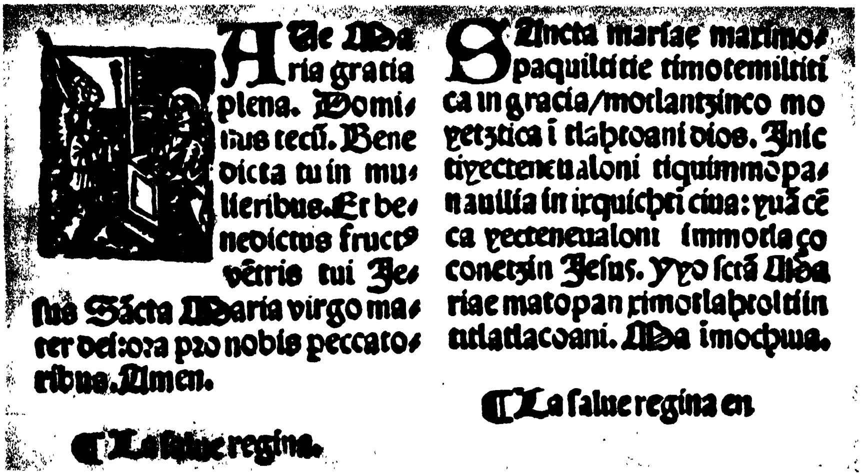
MAMUSSE
WUNNEETUPANATAMWE
UP-BIBLUM GOD
NANEESWE
NUKKONE TESTAMENT
KAH WONK
WUSKU TESTAMENT.

Ne quoshkinnumuk nashpe Wuttinneumoh CHRIST
noh asoowesit
JOHN ELIOT.



CATECISMO MAYOR.

P. Que es Sacramento de Matrimonio?
R. Es vn conciertо firme, y perpetuo del varon, y muger Christianos para engendrar, y criar hijos en servicio de Dios, guardandose lealtad entrambos.
P. Pues esso mesmo no lo tienen los gentiles


Ave Ma
ria gratia
plena. Domi/
nus tecū. Bene
dicta tu in mu/
lieribus. Et be/
nedictus fruct⁹
vētris tui Je/
sus. Sācta Maria virgo ma/
ter dei: ora pro nobis peccato/
ribus. Amen.

Sancta mariae matimo/
paquilitie timotemiltiti
ca in gracia/motlantzinco mo
yetztica i tlahtoani dios. Inic
tiyectenecualoni tiquimmopa/
nauilia in ixquichtin cihua: yuā cē
ca yectenehualoni immotlaco
conetzin Jesus. Ypo sctā Ma
riae matopan ximotlahtolti in
tlatlacoani. Ma imochiua.

Ca salue regina en

Ca salue regina.

71 *In the New World priest and printer, producing devotional books in native languages, helped to begin the study of comparative linguistics. (Bottom, left) Title page of Bible in Algonquin Indian, 1663; (bottom, right) catechism in Aymara and Quichuan, published in Mexico, 1550; (above) Ave Maria in Latin and Mexican, Mexico, 1546. (Top, left) Pages from Joanne Chamberlayne's "De Varius Linguis", published in Amsterdam, 1725.*

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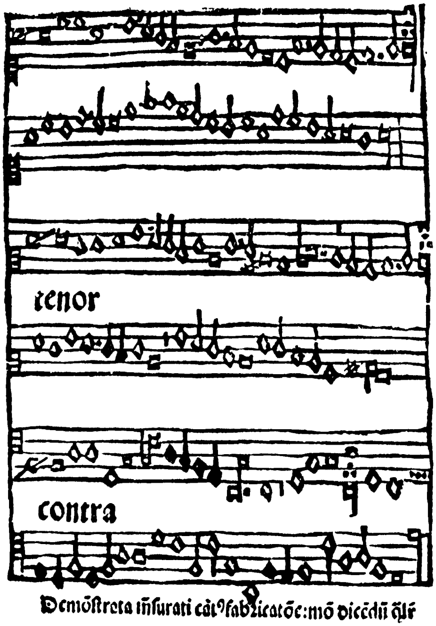
typesetting and the vindication of the set type by the corrected proof. One common way of doing this to-day is to place under hydraulic pressure a sheet of moist and soft cardboard on the type as set up in a frame (*chase*) to take a full section of pages, to dry the resultant mould with the impress of the type, and then to pour over it a molten lead alloy of very low melting point. After cooling quickly, the curved sheet of solidified type metal comes off as a copy of the movable type in relief; and it is now possible to dispense with the latter in its bulky frame. Such is stereotype.

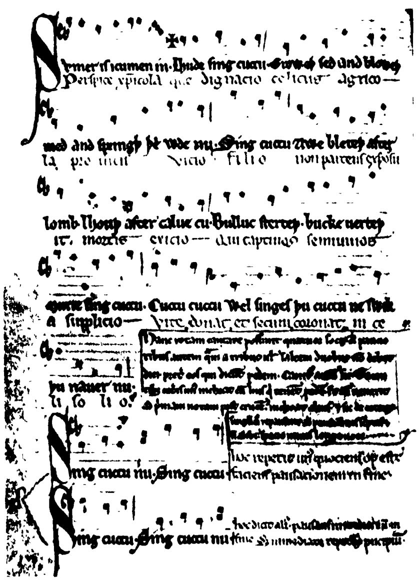
In the course of two centuries, the practice of printing standardised the form of letters used in many European countries in favour of simpler outlines easier to punch and to cast than the ornate forms of the Roman alphabet employed in the missals, while Germany almost alone in Western Europe clung to the Black Letters. In this context, it is therefore pertinent to reflect upon what consequences will follow increasing use of the typewriter in our own time. At first, the typewriter was exclusively an amenity of commercial correspondence. It has recently—within two decades—become a common means of transcription for scientific and statistical scripts containing mathematical formulae involving fractional operations for which the sign $\div$ had fallen into desuetude, except in schoolbooks. It is possible that the convenience of the schoolbook division sign, when it is necessary to rely on the typewriter as a device for transcription of scientific formulae, will rehabilitate its respectability, as it is almost certain that the typewriter will give the *coup de grâce* to vulgar fractions in competition with decimal notation.

When printing began, letters were not the only symbols on whose form the master printers had to arbitrate. Nor was their influence wholly salutary. Ratdolt's *Euclid* published at Venice in 1482 adds nothing to the art of visual exposition as practised six hundred years earlier by mathematicians of the Moslem world, whence Alexandrian geometry made its way into Europe from the Moorish universities of Spain through translations such as those of Adelard of Bath and Gregory of Cremona. To this very day, the teen-ages are handicapped by conventions of reproduction which register no signal advance since Ratdolt's time (Fig. 45).

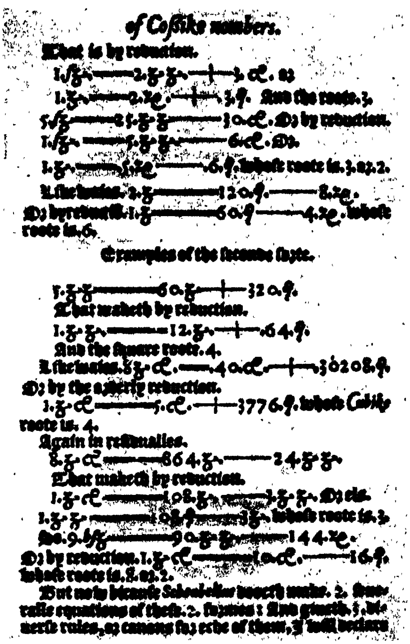
Perhaps, a similar complaint would be justifiable with respect to musical notation. When printing began, the Church was the custodian and patron of an essentially novel instrument, inasmuch as the organ has a keyboard. In the curriculum of mediaeval education music was one of the several liberal arts, and a primitive staff notation for plain-song and chants used in church services was already entrenched in the monastic culture. The earliest book containing music printed from blocks appears to be the *Musices Opusculum* issued at Bologna in 1487. The *Harmonice Musices Odhecaton* printed at Venice in 1501 was a movable-type composition. These foreshadow the distinctive features of musical notation in current use; and it is difficult to believe that a notation, alike more congenial to modern needs and to the convenience of the master printers

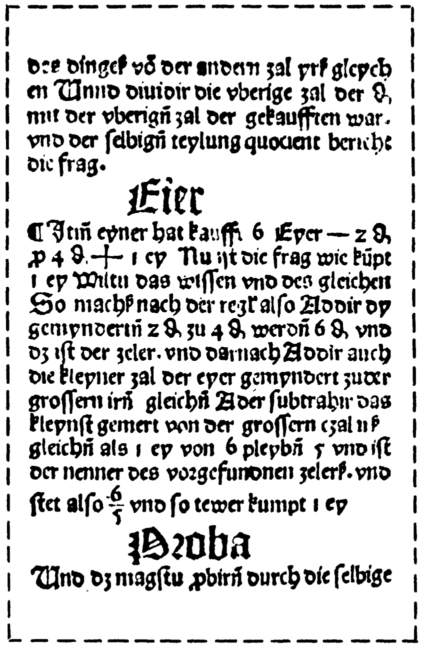
72 When music printing began, monastic ritual had already prescribed the acceptable notation. In following it the master printer failed to produce a script suited to modern needs. (Bottom, left) MS. of English popular song, c. 1280; (right) part of thirteenth-century Spanish MS., Canticles of the Virgin; (top) page from the "Musices Opusculum", 1487, the earliest book with music printed from blocks.


tenor
contra




De loor de santa maria.





73 *Commercial arithmetics from the early printing presses provided an elementary battery of mathematical shorthand symbols, but algebra came to fruition only in the seventeenth century, when printer and pro-fessional mathematician combined to elaborate its grammatical conventions. (Right) Symbols in the Widman Arithmetic, 1489. (Left) Nascent algebra from Robert Record's "Whetstone of Witte", 1557.*

of that time, would have been beyond the ingenuity of man to devise if a pre-existing market of monastic ritual had not prescribed the acceptable formula. For instance, a simple numeral notation for the polytonal system with superscripts and subscripts to specify octaves or time intervals and with brackets for chords would offer no difficulty to the stenographer.

Fortunately, the emergence of one branch of mathematics, delayed by an ancient tradition of clumsy conventions, came to fruition after the printing industry was well established. It is customary to speak of algebra as a contribution made to our own by the Hindu-Arabic culture. This is a misuse of the word, as we understand it to-day. Independently of the

Alexandrians, Hindu and Moslem mathematicians such as Omar Khayyám or Alkarismi had indeed made novel discoveries about series of numbers, as, for instance, the rule for summing the squares or cubes of a sequence of integers; but an equation embodying such a rule when they transcribed it was merely a verbal statement, as when we say: *multiply the breadth of a rectangle by its length to get the area.* If you want to be scholarly, you can indulge in the luxury of calling this rhetorical algebra in contradistinction to the same statement in symbolic algebra as $A=lb$. What we customarily call algebra is in fact symbolic algebra and nothing else. Algebra, as we customarily use the term, is a shorthand.

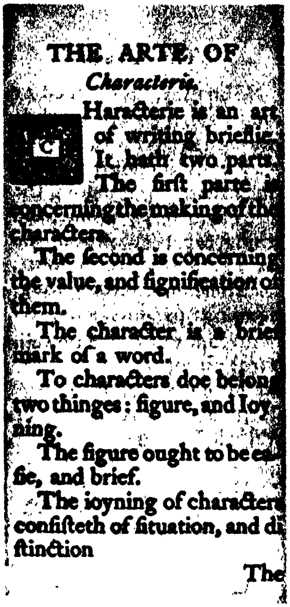
Such a shorthand could not develop within the framework of Alexandrian culture, because the Alexandrians had exhausted the resources of their alphabet to equip themselves with the most elusive of all numeral notations of the ancient world. It might have developed in the Hindu-Moslem world which bequeathed to us the lasting benefit of a more flexible system, and one which made arithmetic as we now use the term possible on paper. In fact it did not. Just as we need both sky-sign signatures and number-symbols to provide the minimum ingredients of a primitive calendar script, we need as well as letters *operative* symbols, such as $+$ and $-$ or $\times$ and $\div$, to provide the materials for an efficient shorthand of number-lore. The commercial arithmetics which came off the first printing presses supplied an elementary battery of such symbols, which probably originated in the counting-house and the warehouse of the merchants of Western Europe. Certainly they did not come from Moorish sources. In the elaboration of the new shorthand of number-lore, the printer collaborated with the professional mathematician with great profit to mankind; and fortunately the printer did not dictate the conventions of numerical grammar or its spelling rules.

Algebraic symbolism is still far from perfect. Many notations compete with one another to the confusion of the learner; and when we take education seriously on a world scale, the international standardisation of mathematical symbols will be no mean task. In one respect, the standardisation of pre-existing conventions when printing was in its infancy makes the task more difficult. Co-ordinate geometry or, as we colloquially call it, *graphical* representation, was a by-product of map-making in the century of the birth of printing; but algebra crystallised in its present form at the beginning of the seventeenth century. By that time, it was already customary to label the side of the graph east of the Greenwich meridian as positive and the side of the graph west as negative. So numbers increase from left to right on the Cartesian framework. This is an unlucky accident, because we exhibit a cypher sequence as referable to increasing powers from right to left when we set out: $351=300+50+1=3(10^2)+5(10^1)+1(10^0)$. If we had adopted the convention of representing positive numbers on the *left* of the Cartesian grid, the use of semi-logarithmic graph paper would be within the comprehension of a normal child of ten.

Mathematicians and natural philosophers with a finger in the pie of algebraic notation during the seventeenth century were not aloof from, or uninfluenced by, the spread of *commercial* shorthand, previously popularised by Timothy Bright and John Willis, two English writers of the sixteenth and early seventeenth century. Perhaps it would be more appropriate to speak of legal shorthand. For the *Art of Stenography*, as John Willis called it, received its first notoriety in the great political trials of the time. In his essays *Not Without Prejudice*, an English judge, Lord Hewart, tells us that there were shorthand reports of the King's speech on the occasion of the impeachment of the five members of the House of Commons on the eve of the Revolution, and that we owe to shorthand our knowledge of the memorable speech made at his trial by John Lilburne, the Leveller. Bishop Wilkins, who popularised Galileo's work in Britain and acted as chairman at the inaugural meeting of the Royal Society, wrote:

> Logarithms were an invention of excellent Art and Usefulness. And yet it was a considerable time before the Learned Men in other parts did so far take notice of them as to bring them into use. The art of Shorthand is in its kind an ingenious device of considerable usefulness much wondered at by travellers that have seen the experience of it in England And yet, though it be above Three score years since it was first Invented, 'tis not to this day (for aught I can learn) brought into common practice in any other Nation. And there is reason enough to expect the like fate for the design here proposed.

 Wilkins is worthy of more than passing comment in our saga of inter-


THE ARTE OF
Characterie.

CHaracterie is an art of writing brieflie. It hath two parts. The first parte is concerning the making of the characters.

The second is concerning the value, and signification of them.

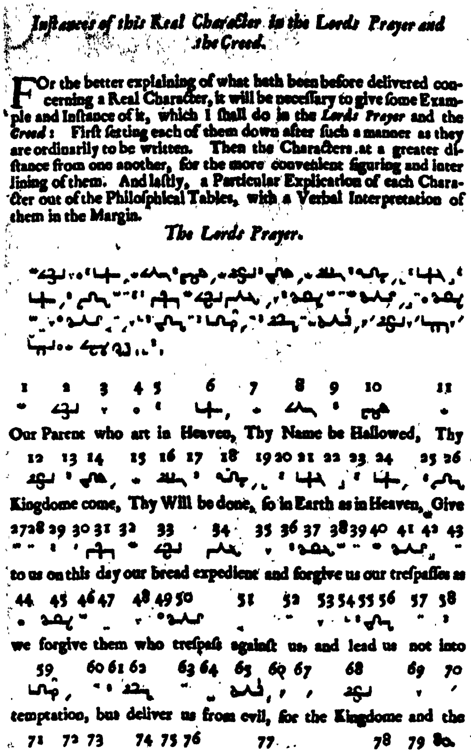
The character is a brief mark of a word.

To characters doe belong two thinges: figure, and ioyning.

The figure ought to be easie, and brief.

The ioyning of characters consisteth of situation, and distinction

The


Instances of this Real Character in the Lords Prayer and the Creed.

FOr the better explaining of what hath been before delivered concerning a Real Character, it will be necessary to give some Example and Instance of it, which I shall do in the *Lords Prayer* and the *Creed*: First setting each of them down after such a manner as they are ordinarily to be written. Then the Characters at a greater distance from one another, for the more convenient figuring and inter lining of them. And lastly, a Particular Explication of each Character out of the Philosophical Tables, with a Verbal Interpretation of them in the Margin.

The Lords Prayer.

1 2 3 4 5 6 7 8 9 10 11
Our Parent who art in Heaven, Thy Name be Hallowed, Thy
12 13 14 15 16 17 18 19 20 21 22 23 24 25 26
Kingdome come, Thy Will be done, so in Earth as in Heaven, Give
27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43
to us on this day our bread expedient and forgive us our trespasses as
44 45 46 47 48 49 50 51 52 53 54 55 56 57 58
we forgive them who trespass against us, and lead us not into
59 60 61 62 63 64 65 66 67 68 69 70
temptation, but deliver us from evil, for the Kingdome and the
71 72 73 74 75 76 77 78 79 80

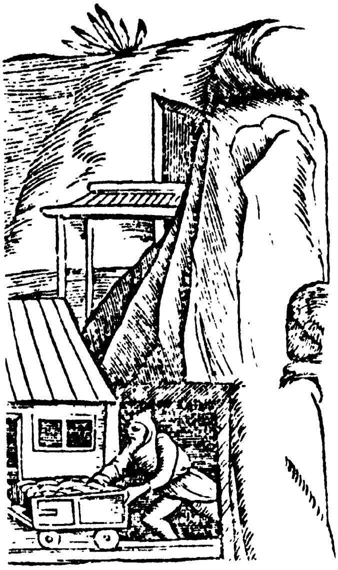
74 *Shorthand developed rapidly in the sixteenth and seventeenth centuries. In 1588 Timothy Bright's "Arte of Characterie" (left) described "a shorte, swifte and secret writing". Bishop Wilkins, in his "Essay Towards a Real Character", 1668 (right), sought to introduce an international auxiliary language, with a form of shorthand, two hundred years before Esperanto.*

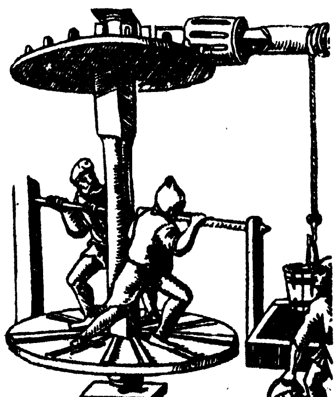
national communications. By order of the Council, the Royal Society published in 1668 an *Essay Towards a Real Character.* Its title coupled with its episcopal authorship discloses no clue to the real character of the treatise itself, that is to say, the design of a constructed auxiliary medium more than two hundred years before Zamenhof's *Esperanto.* It was not the first project for an international language. George Dalgarno of Aberdeen, also author of a deaf-and-dumb alphabet, had published another such in 1661; but Wilkins's essay was on a broader canvas with an introduction on the classification of languages, set out with a shorthand of its own more akin to Chinese writing than to Willis's art of stenography. Leibniz, whose contribution to the symbolism of the infinitesimal calculus revolutionised contemporary mathematics, also devoted some of his phenomenal energy to devising an international medium of communication; and if the work of these pioneers was a magnificent failure, what prompted the undertaking of the task is a question all the more provocative on that account.

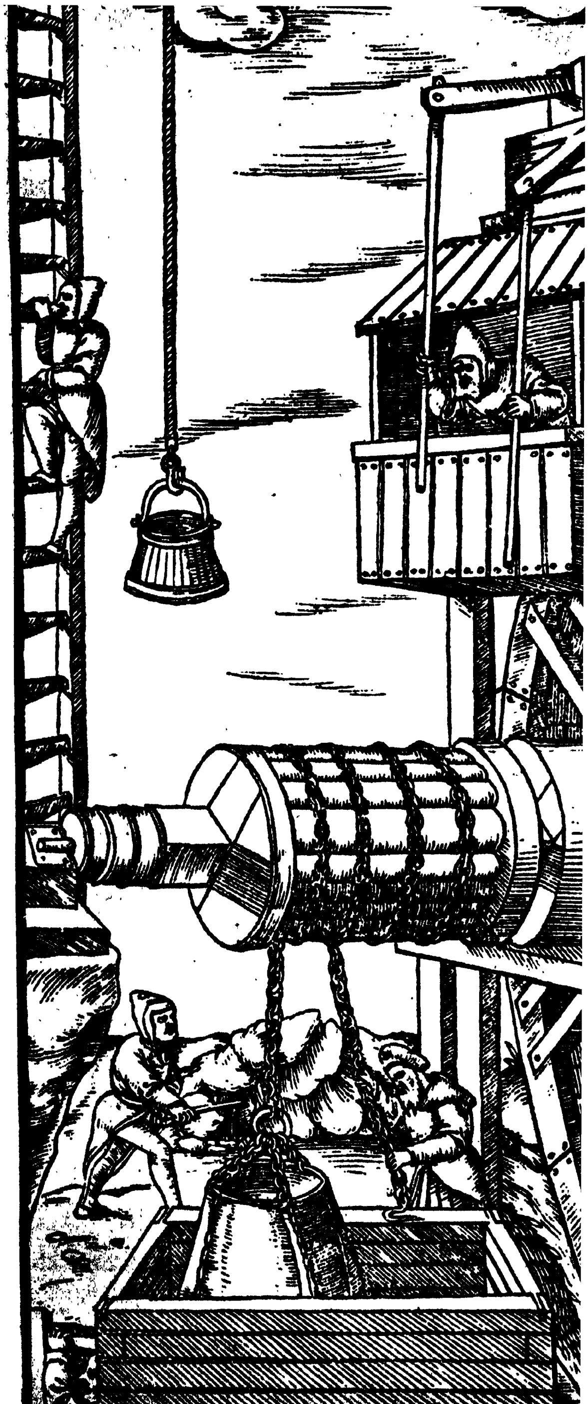
Several circumstances conspired to quicken among the natural philosophers of the age of Leibniz and Wilkins a creative interest in the reshaping of human communications, never since then so widespread. The new shorthand of number-lore had immeasurably simplified computation prerequisite to reaping the fruits of a wealth of new astronomical observations made possible by the invention of new instruments, in particular the telescope and the vernier. Under the impact of new discoveries in ballistics and clock technology the new map-geometry of the Cartesian grid was accomplishing a revolution in the mechanics of celestial bodies. The Puritan revolution had enlisted the Art of Stenography in defence of the right to know, to utter and to argue freely according to conscience. Through the circulation of technological works, such as the beautifully illustrated *De Re Metallica* of Agricola, a treatise on mining technology published in 1556, printing had made mankind script-conscious in a new way. It had brought about a fertilising exchange between expanding scientific theory and practice; and there was thus a personnel eager for printed matter in the vernacular, though unskilled in Latin which had served as the international auxiliary language of mediaeval Europe.

Inescapably and from the start, the newer academies of science in the century of Newton published their transactions in the vernacular; and the fact of doing so restricted free interchange between sister institutions such as the Paris Academy and the English Royal Society, bringing into focus

75 The printing of illustrated technological works, such as Agricola's "De Re Metallica", 1556, from which two of these illustrations are taken, and Sebastian Münster's "Cosmographia Universalis", 1550 (top, left) helped to bring about a fertilising exchange between scientific theory and practice, which was to bear full fruit in the century of Newton.



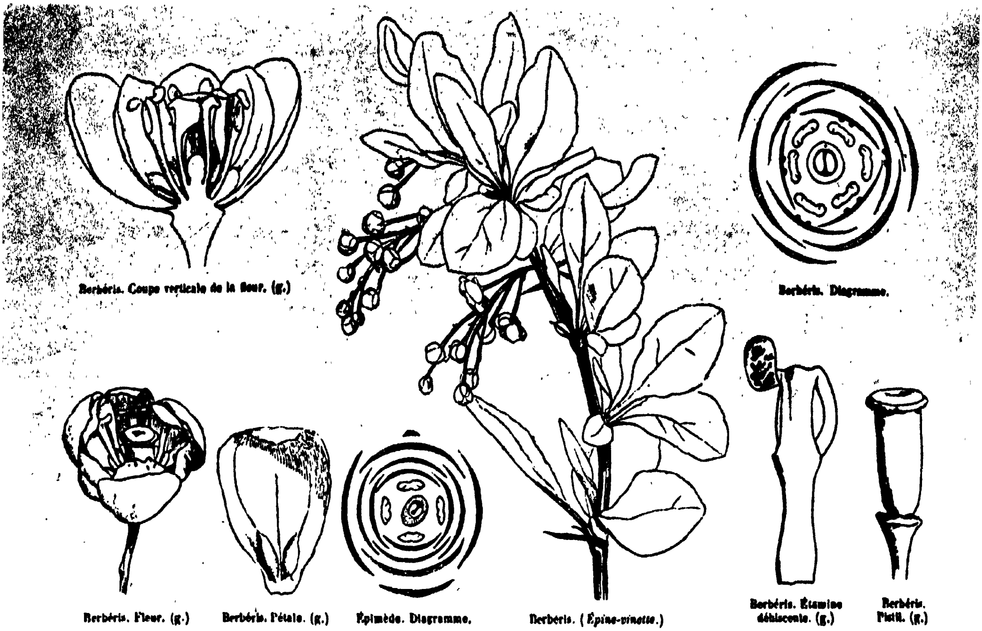




the still unsolved problem of international free speech. It did so at a time when the curriculum of the grammar schools made no provision for the teaching of modern languages, at a time when the grand tour or the private tutor were the only purchasable means of acquiring facility in a living tongue other than one's own. In these circumstances, the very necessary liquidation of Latin as a common medium of communication between the ostensibly learned brought about a state of dietetic deficiency sufficiently acute to demand a remedy. It forced intelligent people to think, as never before or since, about the staggering waste of human energy due to lack of an auxiliary medium of communication transcending national barriers.

To assess the temper of the time, we should also take cognisance of an intellectual catalyst which had no direct connexion with the art of printing. More than a century was to elapse before Napoleon's armies brought back with them the Rosetta Stone which unlocked the secrets of the priestly picture-writing of Egypt; and Caxton's contemporaries knew of no style of writing fundamentally unlike their own. Towards the end of the sixteenth century Jesuit missionaries had penetrated China, and the knowledge of a *genre* of writing by signs, one more akin to algebra than to the western habit of writing by sound, came into Europe during the first half of Newton's century. In the context of the time it was a nine days' wonder; and the trouble which Wilkins takes to vindicate the claim of his *Real Character* to originality by disowning its Chinese parentage is itself a sufficiently eloquent footnote on a contemporaneous renewal of intellectual Marshall Aid from the Eastern civilisation to which we owe both printing and paper.

Indeed, it is fair enough to surmise that the impress of the discovery of a form of writing which permits people who cannot converse to communicate by visual aids was more durable than we commonly suppose. If the pioneers of language-planning—Dalgarno, Wilkins and Leibniz—did not see the promised land which still lies beyond the horizon of intelligent hopefulness, their influence kindled a beacon which the complacency of later times has not extinguished. For they directed attention to the need for standardisation of scientific symbolism with last-



76 *The floral diagrams of the early nineteenth-century botanists added a new device to the making of an international picture language. Flower structure was specified by composite transverse sections showing stamens, petals, carpels and the like, with standard conventions for certain structural idiosyncrasies. (From de Maout's "Atlas Elémentaire de Botanique", 1846.)*

ing consequences. Of the stupendous part which pictorial representation through the medium of printing played in the efflorescence of sixteenth-century science we shall have more to say in another context. Here our sole concern is with the recognition of the pictorial symbol as a means of international communication. Unwittingly, European science had inherited from the priestly scripts of antiquity a battery of zodiacal and planetary symbols, already referred to elsewhere. Progress of plant taxonomy during the eighteenth century in partnership with a flourishing horticultural industry added a new and signal device to the making of a picture-language which oversteps national barriers. In botanical treatises published in the early years of the nineteenth century we encounter floral diagrams (Fig. 76) essentially the same as those in current textbooks.

A floral diagram discloses the structure of a flower as a composite transverse section exhibiting sepals, petals, stamens, carpels and the insertion of the ovules with standard conventions to signify fusion of the sepals or petals at their bases, adhesion of the stalk of the stamen to the corolla and comparable idiosyncrasies of floral structure. It thus sidesteps the need for a paragraph or more of detailed, but less explicit, description relevant to the place of a plant in the classificatory system. P. J. P. Turpin (1819) in his *Mémoire sur l'inflorescence des Graminées et des Cypérées, etc.* exhibits two such examples of the *coupe horizontale d'une fleur*, one of *Gladiolus communis Linn.* and one of *Hydrocharis morsus-ranae Linn.* A. P. de Candolle (1821) also made use of the *coupe transversale de la fleur* in a memoir on the Crucifer family and speaks of it as a *plan géométrique*. Here and there we meet other examples of the same device in the two ensuing decades—de Chamisso (1826) exhibits a transverse plan of the Foxglove (*Digitalis purpurea Linn.*) and Endlicher of other species in works which appeared between 1832 and 1838. The great taxonomical treatise of E. le Maout and J. Decaisne first published in 1868 abounds with floral diagrams of a now internationally standard pattern.

During the nineteenth century pictorial representation of the make-up of molecules, now known as structural formulae, came into general use in the literature of chemistry. Electrical engineering followed suit. Faraday, Kelvin, Maxwell and others blazed the trail. The need was insistent. The scientific worker, who had not always an artist at his elbow, had to have simple conventions to show the build-up of a circuit including batteries, condensers, resistances, choking coils, galvanometers, armatures and cut-outs; and the artist of the time was no longer *en rapport* with the needs of science, as were artists of the age of da Vinci and Dürer. Nor is this surprising. Photography, which the artist had nursed in partnership with the laboratory worker, had deprived him of what had hitherto been

77 *During the nineteenth century structural formulae were introduced showing the make-up of molecules by standard pictorial symbols. Electrical engineering evolved simple symbols for batteries, condensers resistances, and so on, which are now used and recognised internationally.*

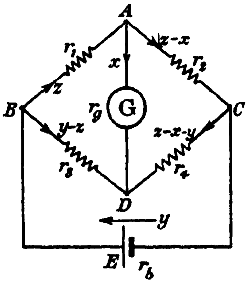
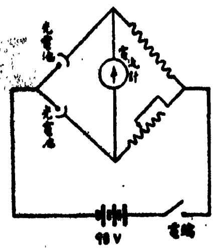


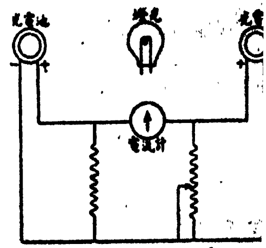
FIG. 30. WHEATSTONE'S BRIDGE NETWORK

[illegible] 光電比色計[illegible]之測定

[illegible] Sheard 及 Osterberg (1933) 等採用此法.不然則可用兩池抵消之[illegible]法 (Two cell balanced-Null point method).此法之應用又可分為兩種:(一)[illegible](Wheatstone bridge method)或光電流抵消法 (Photo curre[illegible] balanced method).用此法者計有 Stier (1934) (如第一圖所示) 及 Withr[illegible] 和 Shrewsbury (1936)(第二圖) 等.(二)電勢平衡法 (Potentiometer balanc[illegible] method)用此法者可以 Bartholomew (1935)的設計為代表,如第三圖所示.(三)用可變溶液層法(Variable Liquid Layer method).創用此法者為 Gou[illegible]



第一圖



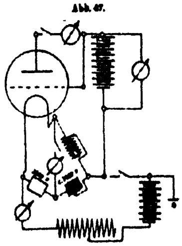
第二圖

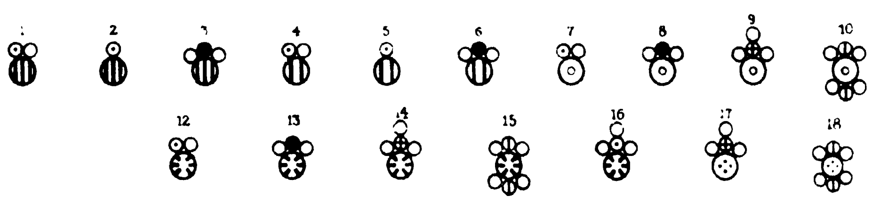
mit 和 Summerson (1935) 兩氏.此法之要點為改變受測溶液層之厚薄,[illegible]其所透射之光正與標準溶液相等.此時兩光電池所生之光電流相等,[illegible]計上指針應回至零點.他們所用的電路——如第四圖所示.(四)可變光[illegible]法 (Variable Light aperture method).此法所用的原理與第三法相同,[illegible]變更溶液層之厚薄,一則變更光之孔徑,其目的皆欲使由受試溶液所[illegible]之光與由標準液者相等.用此法者計有 Zinzadze (1935)等.

此各種方法,驟觀之似頗複雜,惟其施用手續,皆將受試溶液置於一[illegible]池與燈光之間,在其他之光電池與燈光間則置一標準溶液.然後用各[illegible]

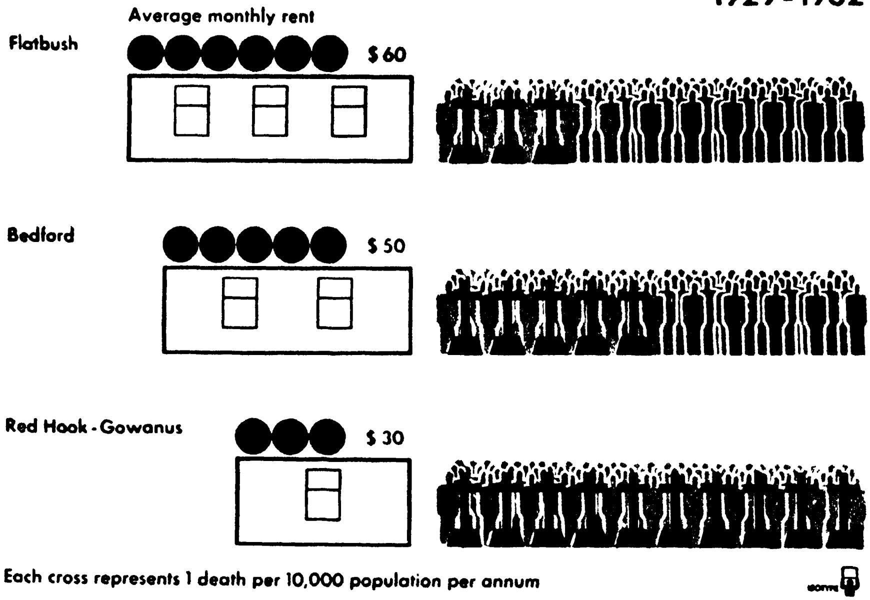
Der Unterschied gegenüber den oben beschriebenen Differenzen besteht darin, daß der niedrigere Strom zu Anfang, im Sättigungsbereich aber der höhere der gesetzmäßige ist. Bei Wolframdrähten erfolgt die Gasabgabe nämlich ziemlich langsam, d. h. wegen der Zerstäubungsgefahr darf sie nicht zu sehr beschleunigt werden [77]), so daß man die Hysteresis weniger auf eine Erleichterung des Austritts als auf Ionisierung im Entladungsraum zurückführen kann. Infolgedessen liegt die richtige Kurve in der Mitte der beiden Schleifenkurven. Die Breite der Hysteresis hängt von der Pumpgeschwindigkeit, dem

Abb. 67.

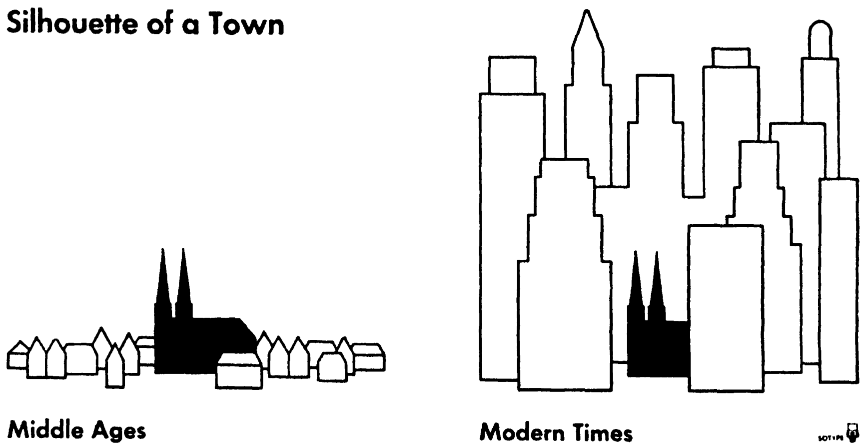




Living-Conditions and Mortality from Tuberculosis in Brooklyn 1929-1932



Silhouette of a Town

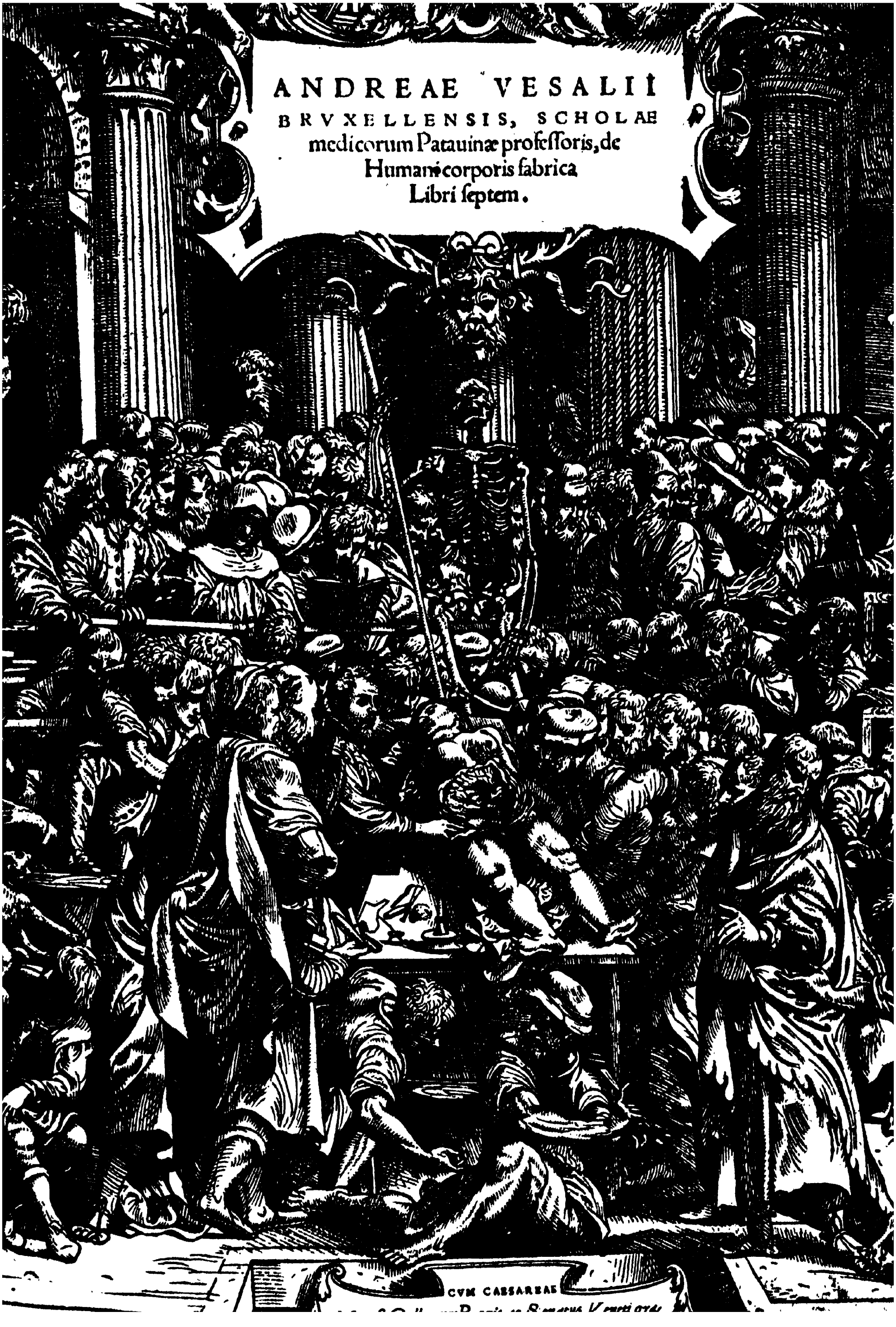


his pivotal social function; and a mood of hostility towards the scientific outlook was already manifest in the artistic milieu.

Easy recognition of the build-up of a circuit, like easy recognition of the make-up of a flower, is possible only when we strip the pictorial components of every feature irrelevant to immediate identification; and in doing so we are retracing the steps by which picture-writing becomes sign-writing with a grammar of its own. The need for such a grammar was evident at the first international congress of electricians in 1881. When the International Electrotechnical Commission met at Paris in 1912, it appointed a special advisory committee "to prepare a set of international graphical sybmols for use in electrical diagrams and installation plans". Meanwhile, neurologists had established a code of conventions to represent the results of research into the analagous issue of how the wires run in the nervous system. In the twenties of our own century the advance of genetics through the study of the chromosomes has equipped the science of heredity with a battery of pictorial symbols recognisable in all countries where scientific literature circulates through the medium of print. Architecture and cartography had recognised conventions in common use in many countries at a much earlier date.

In short, an international picture language was coming to birth in the half-century before our time. To the genius of one man, we owe the recognition of what such a universal picture language can accomplish as an instrument of civic education by recourse to standard symbols for social statistics. In 1925 Otto Neurath established the first institute of visual education by Isotype in Vienna, where he used the schoolchild as the guinea-pig for an experimental study of what elements of a picture are essential to its recognition. He had to flee from Vienna to Holland before the Nazi menace. There he established an Isotype Institute at The Hague in 1934. From The Hague, he escaped to England with his wife and co-worker when Hitler's armies overran Holland. To have enjoyed his friendship during the last four years of his life was the very great privilege of the writer. This book is a tribute to his memory.

78 *In the disciplined symbols of science, picture-writing becomes sign-writing again. It was Otto Neurath who recognised what such a universal picture language can accomplish as an instrument of civic education. (Charts from Neurath's "Modern Man in the Making".)*


ANDREAE VESALII
BRVXELLENSIS, SCHOLAE
medicorum Patauinæ professoris, de
Humani corporis fabrica
Libri septem.
CVM CAESAREAE

FROM CAVE PAINTING TO COMIC STRIP 7

Art, Anatomy and Advertisement

No account of the origins of printing would be complete without reference to ink, an as yet unmentioned prerequisite of reproduction from metal type. It will make a fitting prelude to a just appreciation of the fruitful partnership between the artist and the master printer in the formative phase of the press. For reproduction from wood blocks, the Chinese had used an ink of lampblack suspended in a water solution of gum. Their European pupils followed the same practice. This serves well enough for wood type; but a water ink runs off a metal surface. Movable type, cast in metal, is therefore useful for its purpose only if it is possible to employ ink with suitable adhesive properties. A circumstance contributory to the success of the invention of printing from movable type was therefore the fact that European painters in the fourteenth century had already begun to use natural oils from hempseed or linseed and varnishes from nut oil as a medium in which to suspend a pigment. Ink suitable for the requirements of metal type was a simple adaptation of the artist's oil paints.

The process of taking satisfactory impressions from type carrying more viscous ink entailed a modification of the pre-existing practice of doing it by rubbing or brushing the sheet against the block. More uniformity of pressure was essential; and the means was at hand. Screw-presses had been in use long since for squeezing the juice from the grape and from the olive, for printing designs on textiles, for expressing the moisture from the fibre suspension of the as yet unformed sheet of paper and for flattening out the covers of hand-written books in the course of binding them. In short, the screw-press was already part of the equipment of the printer's craft before the process of taking the impression from the type by means

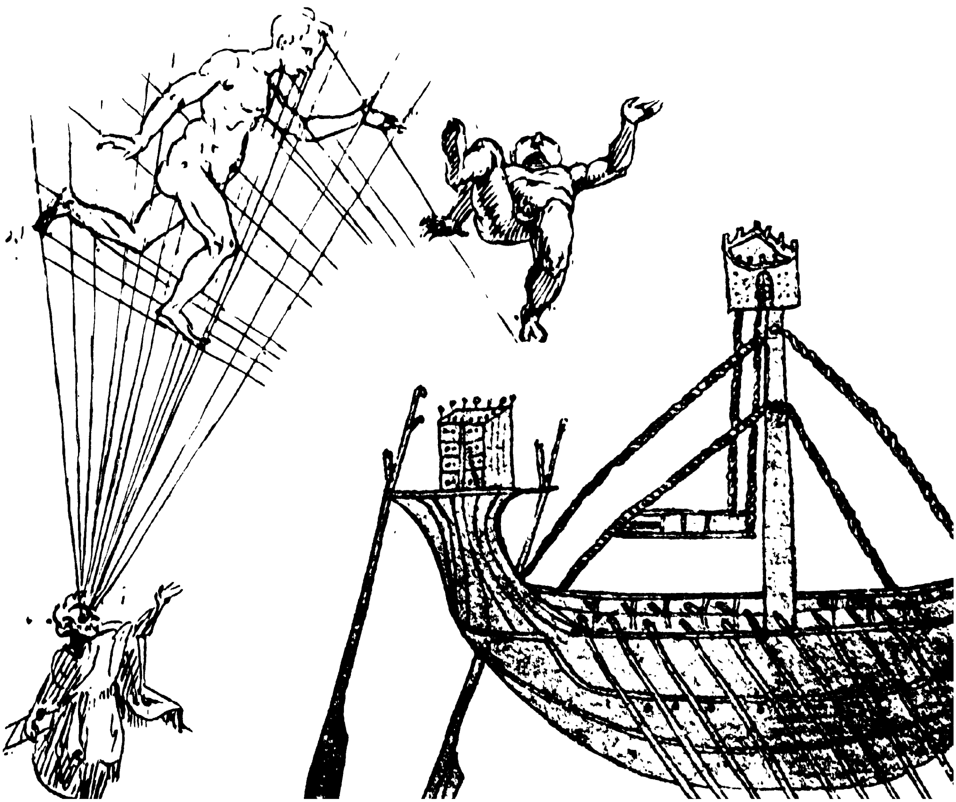
79 *The innovations of the great Renaissance artists, spread by the new craft of printing, profoundly affected the distribution of scientific knowledge, especially in the field of medicine. This frontispiece from Vesalius' treatise on human anatomy was executed by a disciple of Titian.*

of it became necessary. The use of oil paint as a necessary part of the printer's equipment was likewise current before the introduction of movable type. Indeed, we have seen that the art of taking an impression from a clear metal surface from ink adhering to the crevices was already in competition with the older and cruder process of taking it from the raised surface of a wood block. The artist of the time had an active interest in promoting engraving as a more sensitive technique of pictorial reproduction; and the craftsmen themselves were usually goldsmiths whose contribution to the invention of movable type has been the theme of earlier comment.

The partnership of the artist with the goldsmith or the jeweller in the half-century before Gutenberg's press got into action is of less interest than the use to which printing on a larger scale could put the artist's talent. After the invention of printing, innovations of artistic technique during the preceding century exerted an incalculably beneficial effect upon the spread of almost every branch of scientific knowledge, especially medicine. Nor was the influence of the artist a caprice of circumstance. In the age of Leonardo da Vinci, he was not a man aloof from commerce, hostile to science, contemptuous of the claims of society, in the modern tradition. Da Vinci himself would have left an enduring name in the annals of science, if he had never painted a successful picture; and the pivotal artistic innovation of the Renaissance is itself a chapter of scientific discovery in which the artist plays the role of investigator.

What was essentially new in the fifteenth century was the investigation of the laws of perspective and their application; and the investigation itself was the signal of renewed interest in experimental optics. In the Greco-Latin murals and vases of antiquity, in Gothic art and in painting of the Byzantine tradition, we meet with various makeshifts to suggest depth, lines converging to a single axis and lines of different plane sections converging to a single point; but the practice of using a single vanishing-point for all straight lines irrespective of the plane was non-existent

80 *Essentially new in the fifteenth century was the investigation of the laws of perspective and their application. Contrast the attempts to show depth in the war vessel (an eleventh-century drawing) with the lines of vision in the drawing after Leonardo and with the convergence to a single vanishing-point of the ceiling, walls and table-ends in his "Last Supper" (c. 1494).*



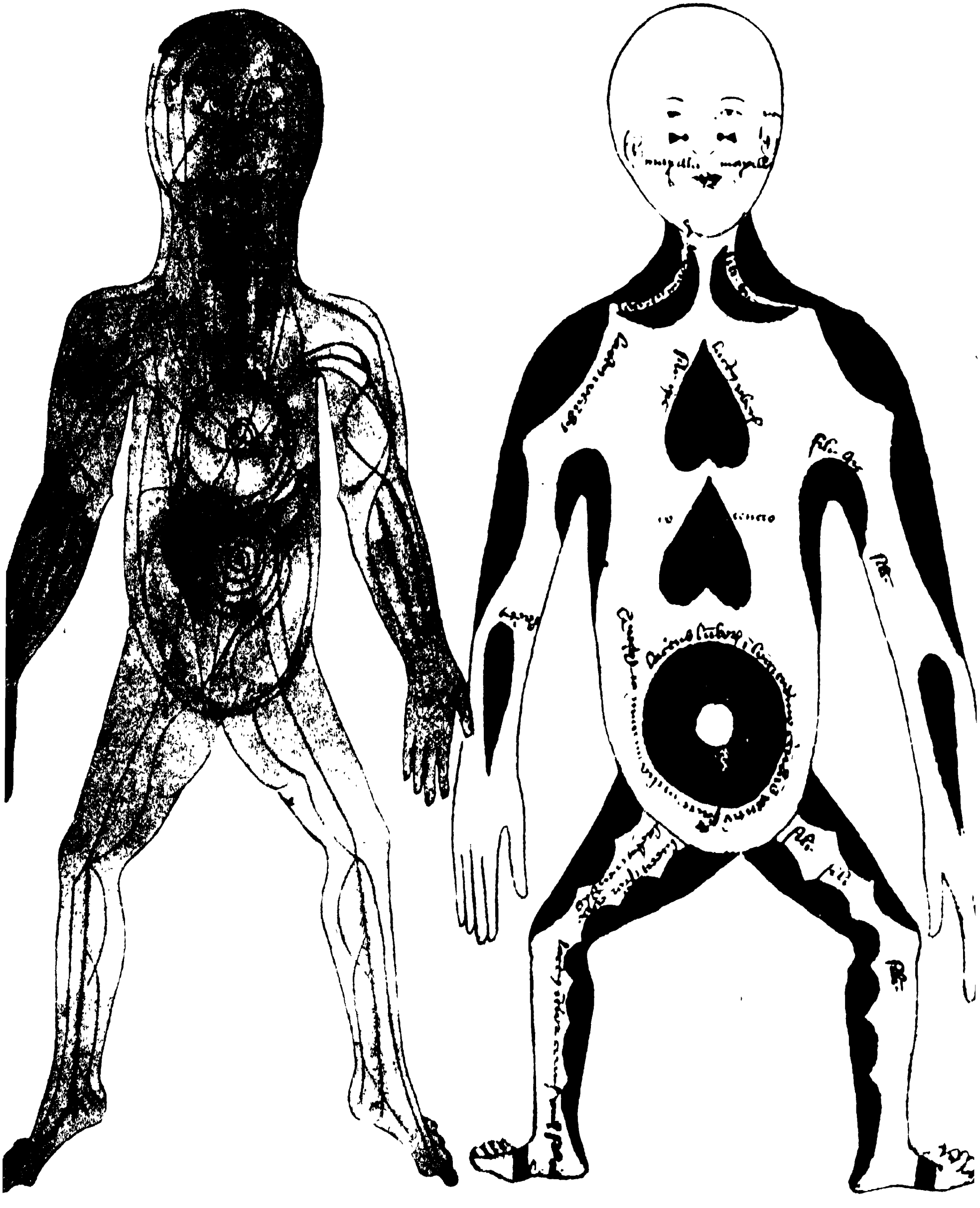
81 *The productions of Albrecht Dürer, whose life-work vindicated the new style, illustrate explicitly the artistic investigation and discovery of his time. This Dürer wood-cut of 1525 shows a glass screen and levelling instrument used as aids to perspective drawing.*

before the end of the fourteenth century. It was the outcome of painstaking investigation into the laws of optics, to which branch of science da Vinci (1452–1519) himself made a noteworthy contribution; and the productions of Albrecht Dürer, whose life-work signalises the final vindication of the new style, exhibit the artist explicitly in the role of discoverer, disclosing what devices he employed to establish its rationale.

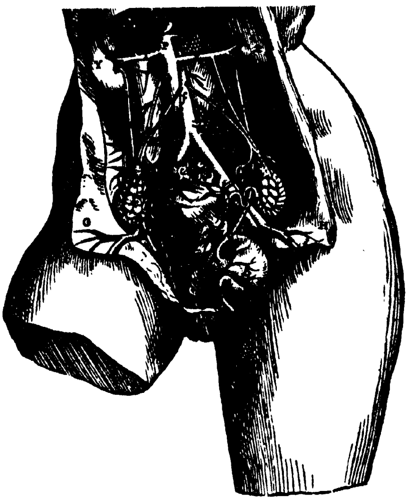
It is not within the prescribed compass of our narrative to record da Vinci's mastery of light and shade to further the stereoscopic illusion, or how Giorgione, Titian and Tintoretto experimented with tonal effects obtainable by playing off opaque and translucent pigments. It suffices to assert that perspective, in the current sense of the term, became the unique feature of European art in an age when the artist was a participant in the advancement of experimental science. Hence it is not strange to record that the artist was also an active partner in the great contemporary awakening of medical science. More than any other circumstance, what makes that great treatise on human anatomy published by Vesalius in 1543 a milestone in the history of medicine is the excellence of its illustrations executed by one of Titian's disciples. Had the *De Humani Corporis Fabrica* appeared without illustration or with wood-block pictures of the sort current before the century of the artist-anatomist, generations of students and commentators might have found substance for endless disputation concerning the author's meaning. The artist-partner in the new venture laid all the cards of anatomy upwards on the dissecting table; and by so doing called the bluff of the authorities. Authors and disciples could no longer hide ignorance behind a mask of verbal ambiguity.

Thus, the new technique of illustration disseminated by the printing press contributed as much as any other single circumstance of the time to a mounting revolt against a heavy load of dead tradition equally entrenched in medicine and metaphysics; and what is true of human anatomy is equally true of botany, then the handmaid of medicine. Even if the therapeutic claims of their recipes had been authentic, the descriptive pharmacopoeias of Egypt, of Greece, of India and of the Moslem world could have made little contribution of value to sixteenth-century medicine. Men of science did not begin to describe plants recognisably till they could draw them recognisably, and without recognisable illustration the interpretation of a verbal description was an invitation to endless inconclusive debate. The new art of illustration was therefore the parent of botanical, and in its turn of zoological, classification at a turning-point of history when colonisation of, and intercourse with, new continents prompted the scrutiny of rich and unfamiliar floras and faunas, at a turning-point of history when the microscope was about to disclose a hitherto unseen world of creatures, some like and others unlike creatures already known to man.

In another field, the master printer had to co-operate with the master mariner and later with the professional astronomer of the learned academies after the partnership of pictorial art and science had run its course. Long before printing of any sort began, map-making was a science; and scientific map-making was from the start a challenge to the illustrator's art. It was so, because the world is not flat like a sheet of paper. The recognition of the sphericity of the earth, foolishly and severally attributed to Pythagoras and to Aristotle by scholars who bask in the self-reflection

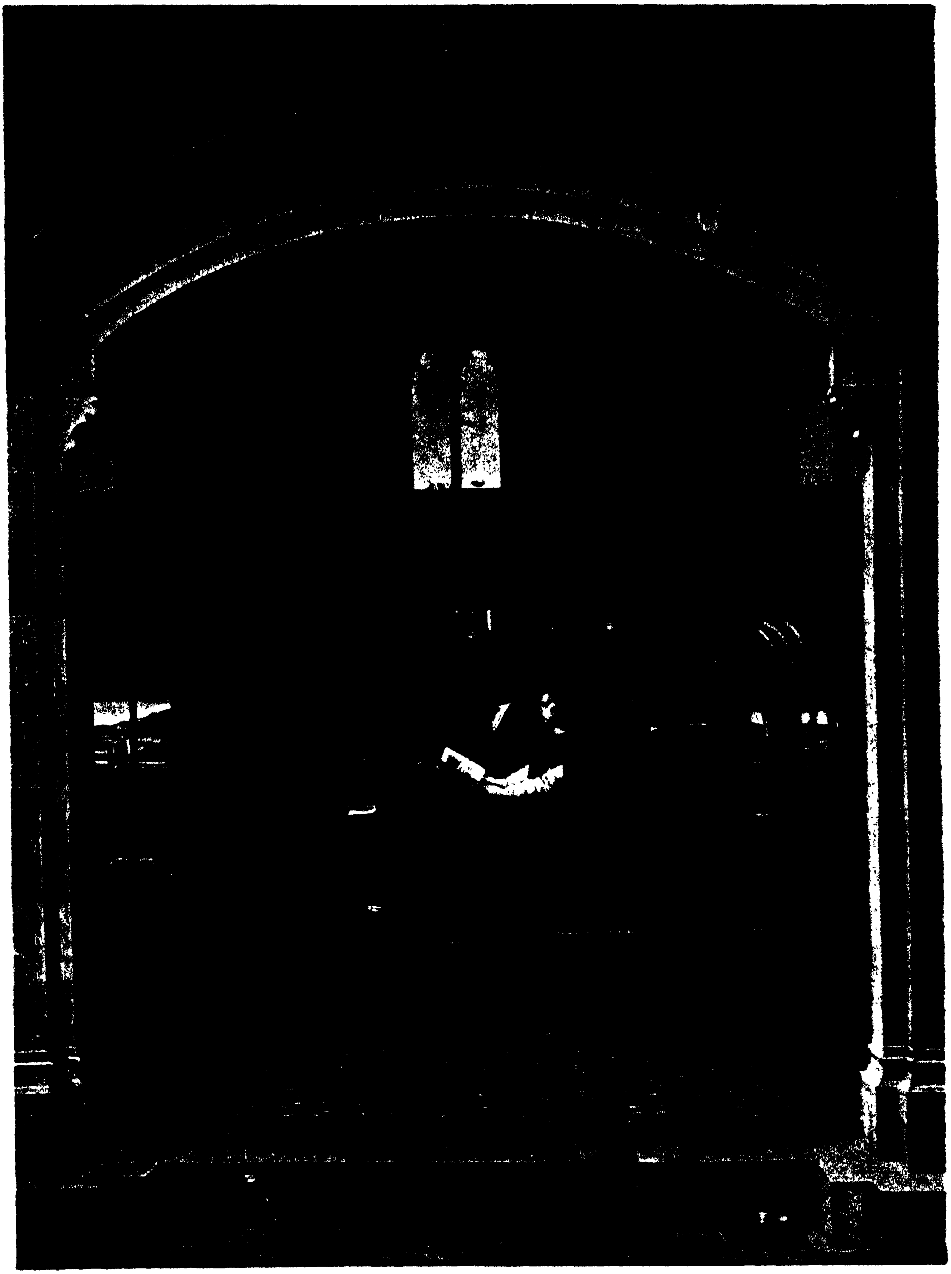


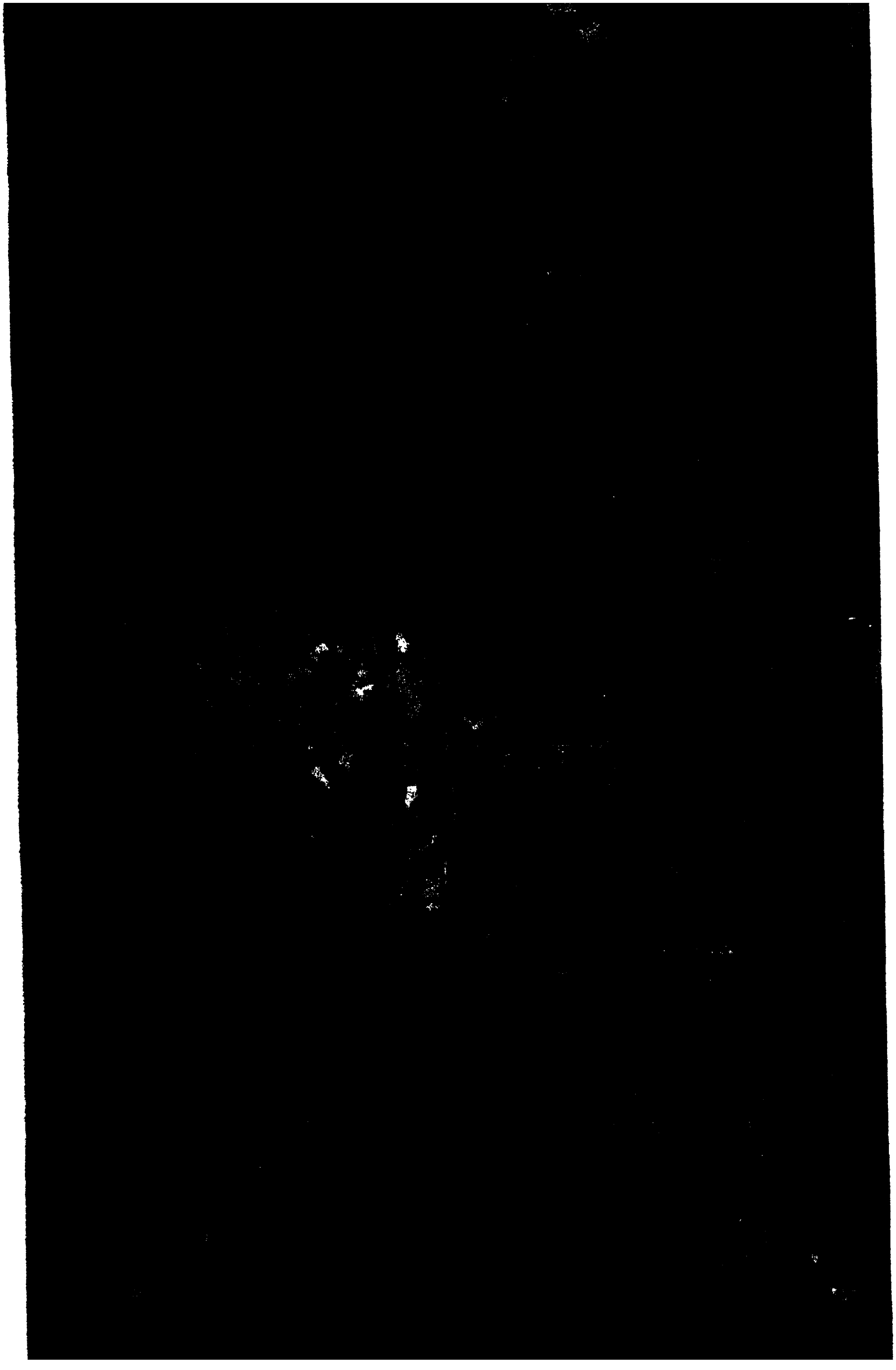
82 *The excellent illustrations of the "De Humani Corporis Fabrica", 1543, for the first time gave precision to the teaching of human anatomy. The two illustrations from Vesalius' great work, on the right, contrast with the anatomical drawings of 1298 and 1399.*



83 *In botany, too, accurate illustration became the ally of science, allowing botanical, and later zoological, classification to go steadily ahead. An Anglo-Norman herbal of the thirteenth century contained the centaury plant (right), whereas John Gerard's "Herball" of 1636 contained the ivy and the bramble (above), and Brunfels' herbal of 1530 the Viola purpurea (below).*


VII *In this age, when the new laws of perspective were introduced into European art, the artist was an active partner in the study of the science of optics. Antonello da Messina (c. 1430–1497), whose 'St. Jerome' is shown here, was one of the pioneers of rational perspective using a single vanishing-point.*



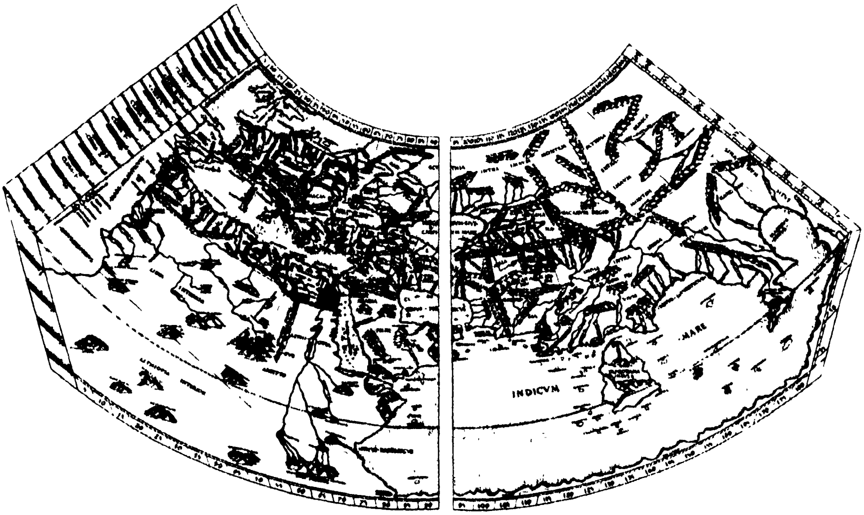


of their own lustre, is of course an unavoidable inference from the experience of pilots who watch the Polar constellations rising or sinking as the ship pushes on its northerly or southerly course. As such, it had forced itself on the consciousness of the practical man so soon as Egyptian ships rounded the Cape in the days of Necho or Phoenician traders went beyond the Pillars of Hercules to the Tin Isles. Indeed, a Phocaean sea captain contemporary with Aristotle gave the latitude of Marseilles correct to one-tenth of a degree. Thus there was a venerable tradition of map-making before printing began.

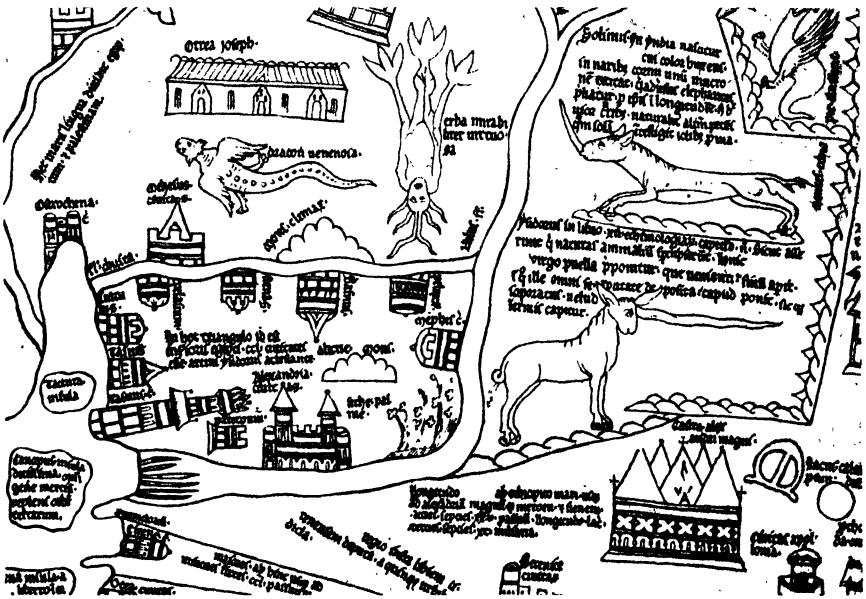
The grid which the priestly astronomers of the most ancient civilisations had used to map the celestial sphere necessarily became the pattern of the sphere terrestrial, when Eratosthenes first estimated (*circa* 250 B.C.) the earth's circumference as about 25,000 miles by comparison of the sun's noon altitude at Alexandria and at Syene. Our first information concerning the details of an attempt at global map-making is that of Marinus of Tyre, about A.D. 130. Thirty years later, Ptolemy issued a famous geography, transmitted through Arabic translations to North-West Europe in the thirteenth century, featuring maps with curved parallels and meridians, the latter based on simultaneous observations of records of the local time of eclipses. Between the age of Ptolemy and the beginnings of printing, Moslem astronomers had ironed out some of the gross distortions due to the paucity of such eclipse observations. Otherwise, Ptolemaic geography was the prescribed pattern, when an efflorescence of maritime enterprise initiated by the Columban voyages set new problems to the printer-publisher with prospects of an expanding market for his wares.

While master mariners of necessity kept alive the knowledge of a science with so long a record, monastic institutions could indulge, and without danger of shipwreck or of failure to bring a cargo into port, in fantasies such as the celebrated *Mappa Mundi* preserved in Hereford Cathedral; but such museum pieces are of little interest except to the psychiatrist. Ptolemy's

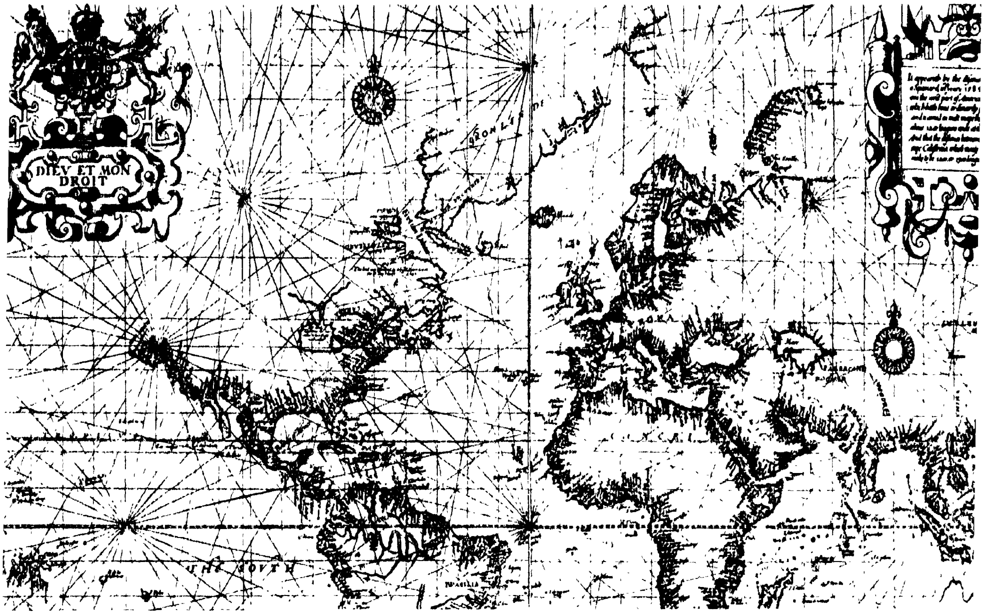
VIII *The artist aloof from science, like the painter of this Chinese picture, "Pavilion in the Mountains", is less concerned with objective reality than with the portrayal of atmosphere. His picture, probably of the seventeenth century, reveals no incentive to apply the rules of perspective.*

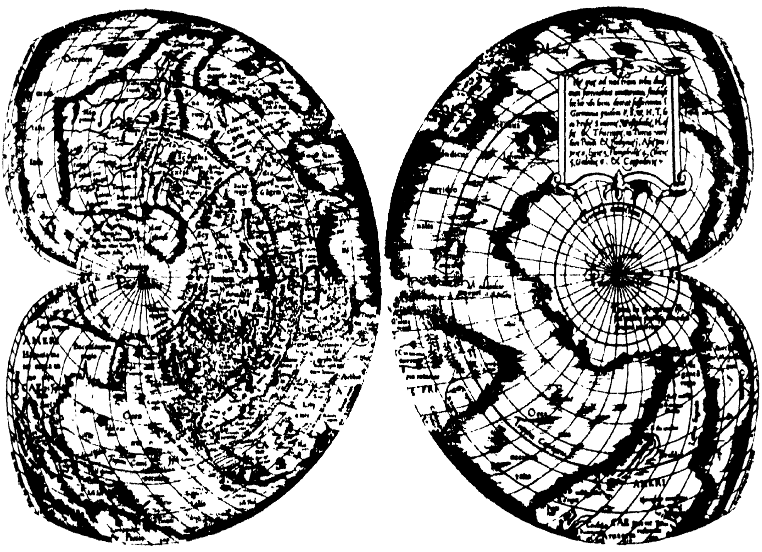


PTOLEMÆUS ROMÆ 1490



84 *Long before printing began, the earth's sphericity challenged the illustrator's art, and map-making was a science. Ptolemy's maps, featuring curved parallels, reached North-West Europe, through Arabic translations, in the thirteenth century, when the Hereford Mappa Mundi (c. 1280) was being drawn*





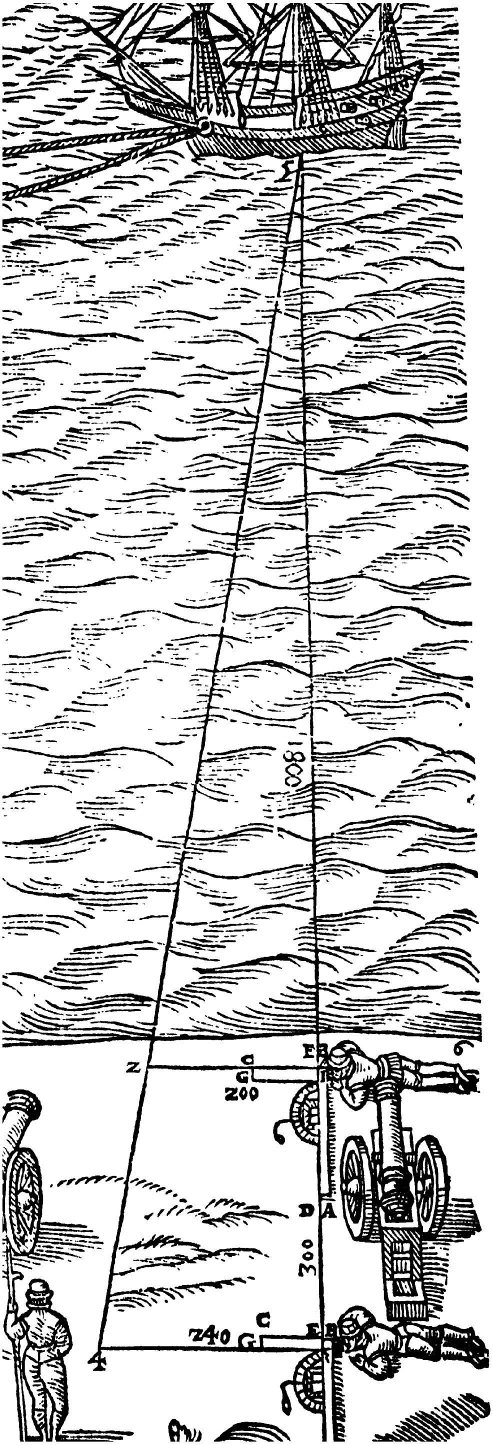
by an ecclesiastic, Richard of Belleau. (Ptolemy, after a version of 1490; Mappa Mundi, detail of Nile Delta) Thereafter cartography developed rapidly. Mercator issued his double cordiform projection (below, right) in 1538, his famous rectangular projection in 1569 (version of 1599 above).

Geographia and *Almagest* were the handbooks of the Great Navigations and the bible of Columbus. A literate class of master pilots of the merchant venturers had their *rutter* books with simple star maps two centuries before the first appearance of Ptolemy's Geography as a printed work in 1475. Thereafter, cartography developed rapidly, especially through the work of Gerhardt Kremer (1512–1594), commonly known as Mercator, who produced the rectangular projection we associate with his name in 1569. A year later his co-worker Ortelius of Antwerp published what we may properly regard as the first modern atlas.

The technical details of the various ways in which cartographers have sought to represent the spherical surface of the earth on a plain sheet of paper would be wearisome to the reader who is not a mathematician. What is important about this opening-up of the mariner-market to the printing trade of the sixteenth century is that it provided a powerful stimulus to mathematical ingenuity in the age of Newton. A by-product whose origin we can trace back to the century of Caxton himself is the new geometry of graphical representation; and this new geometry was to provide a master-key to the problems of mechanics which had arisen through the introduction of gunpowder into warfare, and the improved design of clocks. By circulating maps and illustrated manuals of military ballistics, of mining technology, of architecture and of clock design, as also miscellanies of contemporary crafts, the printing press solemnised a fertile marriage of practice and theory unique in the previous history of mankind and perhaps unique in the historical record to date. The cloistered mathematician of the university now came into courtship with new problems of dynamics, statics, accountancy, surveying and navigational astronomy, hitherto the closely guarded secrets of the craftsman. The child of the marriage was a century of unparalleled intellectual advancement.

When the age of Newton draws to a close, the tempo of scientific discovery has spent its force. The educational significance of the printing trade as a medium of pictorial art henceforth assumes a new aspect, which

85 *The new geometry of graphical representation and the illustrated manuals of ballistics and technology solemnised a fertile marriage between the theory of the mathematician and the practice of the craftsman. Illustrations from Tartaglio's "Colloquies concerning the Art of Shooting" (1588) show range-finding and height-finding for gun fire. The Agricola (1556) shows a composite water-pump in tiers.*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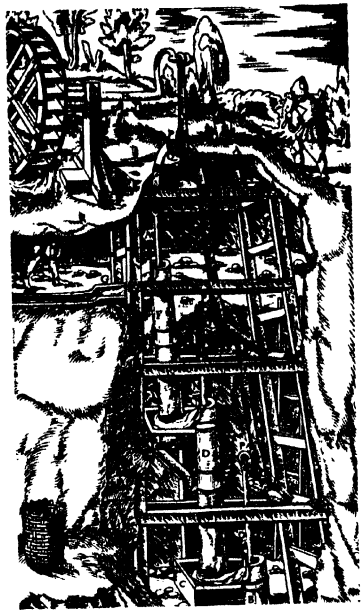

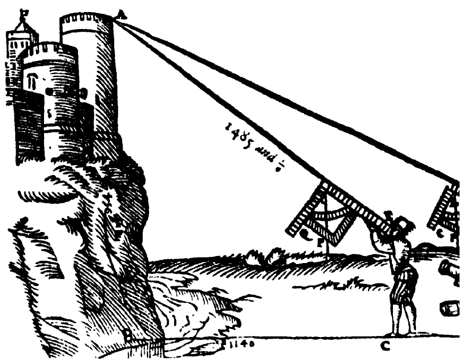
1140

Diligence. *Sedulitas.*

Diligence 1.
loveth labours,
avoideth Sloth,
is always at work,
like the Pismire, 2.
and carrieth together,
as she doth, for her self,
store of all things. 3.
She doth not always
sleep, or make holidays,
as

Sedulitas 1.
amat labores,
fugit *Ignaviam*,
semper est in *opere*,
ut *Formica*, 2.
& comportat sibi,
ut illa, (*am.* 3.
omnium rerum *Copi-*
Non dormit semper,
aut ferias agit,

God. *Deus.*

2

GOD is of himself,
from everlasting to
everlasting,
A most perfect and
a most blessed Being.

In his Essence Spiritual, and one.

In his Personality,
Three.

In his will,
The

DEUS est ex seipso, ab æterno in æternum,
Ens perfectissimum
& beatissimum

Essentiâ Spiritualis &
Unus.

Hypostasi,
Trinus.

Voluntate,

86 *Comenius' "Orbis Sensualium Pictus", 1658, from which these pictures are taken, was illustrated with a realism which sometimes defeated its purpose. But he was one of the great pioneers of educational technique and his book was the first systematic programme of education by visual aids.*

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we may trace to one of Newton's contemporaries, Comenius, a Bohemian divine fêted by the founders of the Royal Society when he visited Britain, and too little recognised as one of the great pioneers of educational technique. He would have been notable, if only because he was responsible for the first systematic programme of education by visual aids, a book which puts before the child a conspectus of contemporary general knowledge in lively contact with the common life and everyday work of mankind, abundantly—though not very attractively—illustrated with a realism which sometimes defeats its end. For it was an error of judgment to represent celestial beings in fancy dress at a time when Protestant ideology frowned on any deviation into iconography as contrary to the party line.

Some of the sayings of Comenius are well worthy of citation. "Schools", he says, "are slaughter houses of the mind where *ten or more years are spent on learning what might be acquired in one* . . . places where minds are fed on words." The preface of his children's encyclopaedia (*Orbis Sensualium Pictus*) sets out his programme and principles as follows:

> I say and repeat with loud voice . . . that we can neither put into effect nor discuss reasonably, unless we have first understood properly all that has to be done or has to be discussed. But there is nothing in the intellect which has not first been in the senses. If the senses are thoroughly trained to understand the difference of the things well, it is practically the same as to lay the foundation to all wisdom, wise eloquence and all clever acts of life. . . . So you see a new aid for the schools, namely the picture and catalogue, for all the fundamental things in the world and acts of life. . . . Prepared in this way this book will serve, I hope, firstly to attract the mind, so that it conceives the school not as a crucifixion but as sheer delight. . . . Secondly the book serves to arouse attention, to direct it to things and to sharpen it more and more, which is something great in itself too. . . . From that the third use will follow, namely that pupils attracted thus far, and thus aroused into attention, will absorb knowledge of the fundamental things of the world by pastime and pleasure.

Maybe Comenius was born too early, maybe too late. Either way, he was born out of his time. The first fine flush of curiosity after the great miscegenation of theory and practice in the preceding century was abating. The century between the publication of Wilkins's *Real Character* and the Declaration of Independence of the Thirteen States is a dreary anticlimax with a bleak prospect for pioneers of any sort. How bleak we can judge from the prose of the man whose pretentious pedantry, sonorous pomposity and moral vulgarity dominates the English scene. Referring to Milton's brief experience as a schoolmaster in Aldersgate, Dr. Johnson (*Lives of the Poets*) pronounces the epitaph of his own on the stillborn impulse to educational reform in the preceding century:

> The purpose of Milton . . . was to teach something more solid than the common literature of schools, by reading those authors that treat of physical subjects; such as the Georgic and astronomical treatises of the ancients. . . . But the truth is that the knowledge of external nature, and the sciences which that knowledge requires or includes, are not the great or the

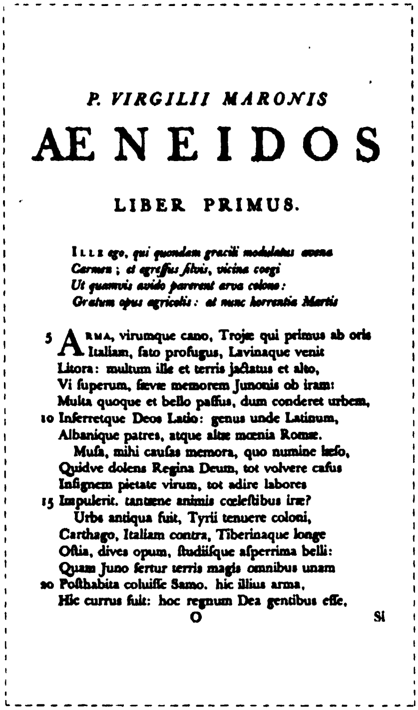
frequent business of the human mind. Whether we provide for action or conversation, whether we wish to be useful or pleasing, the first requisite is the religious and moral knowledge of right and wrong. . . . Prudence and justice are virtues and excellencies of all times and of all places; we are perpetually moralists, but we are geometricians only by chance. Our intercourse with intellectual nature is necessary: our speculations upon matter are voluntary and at leisure. Physiological learning is of such rare emergence, that one may know another half his life without being able to estimate his skill in hydrostatics or astronomy; but his moral and prudential character immediately appears.

Much water had to flow under the bridges before it was possible to implement the programme of pictorial education foreshadowed by Comenius. Indeed, it was not practicable before a succession of technical innovations during the nineteenth century provided the tools. In our admiration for the boldness of his originality, we need not therefore shirk the obligations of candid authorship. The truth is that the pictures which adorn the pages of the first children's encyclopaedia and the pioneer primer of education by visual aids are execrable, unavoidably so for two reasons. First for one already indicated, that is to say the limitations of available technique for printing pictorial matter cheaply, but no less also because they are quasi-artistic productions commissioned without regard to principles of design with an educational end in view. Two centuries of progress in the standardisation of symbols, as recorded in our last chapter, must needs elapse before a Neurath could conceive the possibility of a universal picture-language.

Progress of chemical knowledge in the seventeenth century encouraged the substitution of etching by the action of an acid through scratches made on a shellac film for the mechanical device of directly engraving the metal surface as practised hitherto. The invention dates from the first half of the sixteenth century in the context of armoury, and was indeed exploited by Dürer in his later period. The last decade of the eighteenth century sees the beginnings of *lithography,* a process of taking impressions from a smooth fat-absorbing limestone surface which soaks up a greasy ink without smudging. One of the two cardinal advances in pictorial reproduction during the ensuing century was photography, of which we shall have more to say in another setting. The other was the three-color process. Heretofore, the most satisfactory method of colored reproduction was lithographic, and color lithography itself did not come to fruition until about 1840. The three-color process signifies successive imposition on the same sheet of impressions from different plates or blocks respectively carrying the colors blue, yellow and red. It signalises a new event in the history of printing, inasmuch as theory is now the pacemaker of practice, since the process itself derives its rationale from Newton's own discovery of complementary colors. Among those who actively contributed to its development at the beginning of the second half of the century was indeed Clerk-Maxwell, the founder of the modern school of theoretical physics.

Before such technical inventions could hold out prospects of educational progress now in sight, the printing trade had to find new markets for its wares and especially a new market for illustration through the marriage of advertisement to a sensationalist daily press. This too was essentially a phenomenon of the latter part of the Victorian age, though we may trace its origins to that of Johnson. The century of the mercantile nabobs and the literary mandarins registers no signal advance in science or in education comparable to those of Newton's day or to that of Faraday when theoretical science and the everyday business of mankind re-established contact. It is at best a period of consolidation in which there was steady advance in the crafts of illustration and typography. Towards its end, engraving had reached a higher level than ever before, enlisted more than ever before by artist-printers, such as William Blake, the poet, in the service of a literature for leisure. Baskerville of Birmingham, a friend of Benjamin Franklin and a notable eccentric in the best tradition of English eccentricity, is mentionable as one of those who set a new standard in fine printing; but no incident in the technology of the time is notable in the sense that the cylinder power press, the sulphite wood pulp process or the introduction of the linotype machine is notable as we approach more closely to our own time. In Scotland, with a long start over her southern neighbour with respect to dispersion of educational opportunity, the publisher is an emergent phenomenon of the closing years of the century.

In retrospect, the expansion of a literature of leisure side by side with



P. VIRGILII MARONIS

ÆNEIDOS

LIBER PRIMUS.

Ille ego, qui quondam gracili modulatus avena
Carmen; et egressus silvis, vicina coegi
Ut quamvis avido parerent arva colono:
Gratum opus agricolis: at nunc horrentia Martis

Arma, virumque cano, Trojæ qui primus ab oris
Italiam, fato profugus, Lavinaque venit
Litora: multum ille et terris jactatus et alto,
Vi superum, sævæ memorem Junonis ob iram:
Multa quoque et bello passus, dum conderet urbem,
Inferretque Deos Latio: genus unde Latinum,
Albanique patres, atque altæ mœnia Romæ.
Musa, mihi causas memora, quo numine læso,
Quidve dolens Regina Deum, tot volvere casus
Insignem pietate virum, tot adire labores
Impulerit. tantæne animis cœlestibus iræ?
Urbs antiqua fuit, Tyrii tenuere coloni,
Carthago, Italiam contra, Tiberinaque longe
Ostia, dives opum, studiisque asperrima belli:
Quam Juno fertur terris magis omnibus unam
Posthabita coluisse Samo. hic illius arma,
Hic currus fuit: hoc regnum Dea gentibus esse,

O Si

87 *Dr. Johnson's century, registering no such advance in science or education as its predecessor, was a period of steady consolidation in the crafts of illustration and typography. William Blake's engraving (1791) and the first page of Baskerville's Virgil (1757) are examples.*

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a literature of political controversy, in contradistinction to a literature of technology and scholarship, is perhaps the most significant feature of the eighteenth century as an episode in the development of human communications. In the English-speaking world we may regard Defoe and Goldsmith as the parents of the fiction-reading habit. Addison and Steele stand out as pioneers in *periodical* production. Neither the one nor the other registers a signal advance in its own context; but each is an omen of the wider literacy of our own times. If there were still few who

 read daily or read much by modern standards, though proportionately far more than had ever read at all in past times and proportionately far more whose reading was mainly secular, there is at least a premonition of reading as a hobby and as a daily routine.

If this were a book with any pretensions to cloistered scholarship, it would be necessary to expand the theme of the preceding paragraph by reference to the picaresque romance of the Middle Ages. It would be essential to comment on the tradition of the broadsheet ballad. It would be fitting to recall the content of the first translations of Caxton himself. We should then be in the respectable tradition of anaemic erudition which turns its face away from the claims of our common humanity; and could go to press with the *nihil obstat et imprimatur* of the Mandarin hierarchy. Our enjoyment of Marie Neurath's picture gallery in this book needs no such indulgence. The writer sees it as a record of how man has become a communicating animal. If it is here appropriate to touch on the lighter side of literature, it is appropriate only because of what it contributes to an understanding of the crowning mercy of universal literacy in our own day and generation throughout the Anglo-American-speaking community.

Before we seek for clues to this essentially novel feature of our contemporary common civilisation, we must get the culture of the nineteenth century into focus anew. The nineteenth century witnessed an unprecedented tempo of changing social *mores* under the impact of two new sources of power, first steam, later electricity; and in England, where steam power came into use in a big way during the closing decades of the eighteenth century, one may surmise that the immediate effect of driving the already semiliterate craftsman from his home into the new factories, where married women and children toiled with no restrictive legislation on long hours, was a setback in the national standard of literacy for the better part of seventy years after the partnership of Boulton and Watt began. What emerges clearly from the work of public commissions which reported from time to time on the state of English education is that illiteracy was still widespread both among the unskilled section of the labouring population and throughout the countryside in the eighties of the last century.

The pedagogue and the scholar may deny that subsequent change calls for any explanation other than more ample provision of schooling facilities for the population as a whole by government intervention under the pressure of scholarly philanthropists, employers with a realistic view of the requirements of a wage economy, religious denominations competing for converts, and the several interests of a rapidly expanding trade in printed matter. This is true in the sense that no animal species comes into the world with a knowledge of letters; but zoology also teaches us a truth enshrined in the English proverb: you can take a horse to the water but you cannot make it drink. From about 1860 permissive education Acts, consolidated in the compulsory powers of the Act of 1902, took the English horse to the water; but only those who believe that the cane is a sufficient safeguard of educational progress will feel satisfied with an explanation of the rapidity with which England became a literate nation unless it also offers a recipe for getting the horse to drink. Only those who enjoy a high standard of leisure with an assured income off-stage will be satisfied with an explanation which fails to furnish an answer to the question: by what means is it possible to give an as yet underprivileged segment of the population an ever-present incentive to cash in on what little they reluctantly learn at school?

It would be a pleasant gesture, if also true, to record that contemporary humanistic scholarship has undertaken an accessible and comprehensive survey of the progress of literacy in western civilisation as a whole; but the writer is unable to assure himself that humanistic scholars in our western universities have indeed profaned the gentlemanly tradition of Cambridge and Harvard, Oxford and Yale by extensively investigating an issue so relevant to the needs of mankind on the threshold of the Atomic era. Unhappily, it is impossible to find any adequately documented statistical account of the way in which western nations have severally solved an as yet unsolved problem of a not inconsiderable slab of living humanity. For lack of it, one has to rely on the experience of a lifetime during which those of us now in our fifties have enjoyed the role of spectator.

What incentives to this wider literacy were more or less decisive in different countries were certainly various. In America, the frontier tradition fostered an eagerness for self-betterment and for the betterment of one's children peculiar to the local scene. Even in the British Isles the main outlines are quite different on the two sides of the Tweed. In his own setting, John Knox, who regarded a free passport to Bible reading as the birthright of every child, set before his contemporaries a goal beyond the imaginative reach of his southern neighbours two hundred years later; and if he did not live to see the end of the game, it is likely enough true to say that the Scotland of 1700 was vastly more literate than England in 1800. By 1800 Scotland had endorsed book learning with a peculiar reverence which Englishmen as a whole have never shared.

This remarkable enthusiasm illustrates a thesis brilliantly documented in *Growing-up in New Guinea*. Maybe it is good for the morale of the schoolteacher to spread the belief that the technique of instruction fashions the environment in which the appetite for knowledge thrives; but experience of educational progress in communities with different *mores* discloses a different picture. For the school environment can offer little incentive to study, if society as a whole fails to do so. Against its own hope-generating background of frontier tradition and rugged individualism, the American schoolchild suffers no apparent handicap from liberties which others would call licence and self-indulgence. Scottish school discipline has been, and still is by American standards, harsh; and Scottish children seem to thrive on it. For Scotland in a different sense had a frontier to conquer.

The repressive Acts of the reign of Charles II deprived the English nonconformist of the right to hold public office till 1824 and from the right to university residence till 1870. Hence the great English scientists of the Industrial Revolution, recruited from a rising middle class so largely Methodist, Quaker and Congregationalist, were seldom university men, as were the leaders of science in Newton's time. Priestley was not, neither were Davy, Dalton, Faraday, Henry and Joule. Positions of professional prestige in their time were for Scotsmen who benefited from the Union of 1707, because the Deity entertains different views about church government and predestination in different parts of the British Isles. In virtue of the fact that the King is alike head of the English and

LONDON, THURSDAY, NOVEMBER 7, 1805.

The LONDON GAZETTE EXTRAORDINARY
WEDNESDAY, Nov. 6, 1805.

ADMIRALTY-OFFICE, Nov. 6.

Dispatches, of which the following are Copies, were received at the Admiralty this day, at one o'clock A.M. from Vice-Admiral Collingwood, Commander in Chief of his Majesty's ships and vessels off Cadiz:—

SIR, *Euryalus, off Cape Trafalgar, Oct. 22, 1805.*

The ever-to-be-lamented death of Vice-Admiral Lord Viscount Nelson, who, in the late conflict with the enemy, fell in the hour of victory, leaves to me the duty of informing my Lords Commissioners of the Admiralty, that on the 19th instant, it was communicated to the Commander in Chief, from the ships watching the motions of the enemy in Cadiz, that the Combined Fleet had put to sea; as they sailed with light winds westerly, his Lordship concluded their destination was the Mediterranean, and immediately made all sail for the Streights' entrance, with the British Squadron, consisting of twenty-seven ships, three of them sixty-fours, where his Lordship was informed, by Captain Blackwood (whose vigilance in watching, and giving notice of the enemy's movements, has been highly meritorious), that they had not yet passed the Streights.

On Monday the 21st instant, at day-light, when Cape Trafalgar bore E. by S. about seven leagues, the enemy was discovered six or seven miles to the Eastward, the wind about West, and very light; the Commander in Chief immediately made the signal for the fleet to bear up in two columns, as they are formed in order of sailing; a mode of attack his Lordship had previously directed, to avoid the inconvenience and delay in forming a line of battle in the usual manner. The enemy's line consisted of thirty-three ships (of which eighteen were French, and fifteen Spanish), commanded in Chief by Admiral Villeneuve: the Spaniards, under the direction of Gravina, were, with their heads to the Northward, and formed their line of battle with

in their country's service, all deserve that their high merits should stand recorded; and never was high merit more conspicuous than in the battle I have described.

The Achille (a French 74), after having surrendered, by some mismanagement of the Frenchmen, took fire and blew up; two hundred of her men were saved by the Tenders.

A circumstance occurred during the action, which so strongly marks the invincible spirit of British seamen, when engaging the enemies of their country, that I cannot resist the pleasure I have in making it known to their Lordships; the Temeraire was boarded by accident, or design, by a French ship on one side, and a Spaniard on the other; the contest was vigorous, but, in the end, the Combined Ensigns were torn from the poop, and the British hoisted in their places.

Such a battle could not be fought without sustaining a great loss of men. I have not only to lament, in common with the British Navy, and the British Nation, in the Fall of the Commander in Chief, the loss of a Hero, whose name will be immortal, and his memory ever dear to his country; but my heart is rent with the most poignant grief for the death of a friend, to whom, by many years intimacy, and a perfect knowledge of the virtues of his mind, which inspired ideas superior to the common race of men, I was bound by the strongest ties of affection; a grief to which even the glorious occasion in which he fell, does not bring the consolation which, perhaps, it ought: his Lordship received a musket ball in his left breast, about the middle of the action, and sent an Officer to me immediately with his last farewell; and soon after expired.

I have also to lament the loss of those excellent Officers, Captains Duff, of the Mars, and Cooke, of the Bellerophon; I have yet heard of none others.

I fear the numbers that have fallen will be found very great, when the returns come to me; but it having blown a gale of wind ever since the action,

88 *The closing years of the nineteenth century which saw the beginning of a dramatic liquidation of illiteracy, to which printer and publisher contributed the incentive of cheap, attractive reading. The "Times" account of the battle of Trafalgar contrasts with the new journalism of the "Daily Mail".*

5.0 A.M. EDITION.

HOW CRIPPEN WAS DISCOVERED.

COMPLETE STORY

FROM CAPTAIN OF THE MONTROSE.

BY MARCONI WIRELESS TO "THE DAILY MAIL."

A week ago we telegraphed to Captain Kendall, of the steamship Montrose by Marconi wireless, asking for an account of the identification of Dr. Crippen and Miss Le Neve. Yesterday afternoon we received the brief message printed in another column, and this morning after the ordinary edition of *The Daily Mail* had gone to press we received the following detailed message from the captain giving the story of the fugitives' life on board his steamer:

CAPTAIN'S TELEGRAM

SURPRISE FOR CRIPPEN.

"NO SUSPICION."

CAPTAIN'S MESSAGE TO "DAILY MAIL."

INSPECTOR DEW'S ARRIVAL.

ARREST EXPECTED TO-MORROW.

Crippen and Miss Le Neve, on bo[ard] the Montrose, are now in the Gulf of [St.] Lawrence, and due at Father Po[int,] near Rimouski, 170 miles from Quebec [at] 10 a.m. (3 p.m. Greenwich time) to-morrow.

Inspector Dew, in the Laurentic, [ar]rived at Father Point at 4 p.m. (9 [p.m.] Greenwich) yesterday, and awaits [the] fugitives.

SLEEPLESS AT NIGH[T]

CAPTAIN'S FIRST STORY [OF] THE FUGITIVES.

By MARCONI WIRELESS.

S.S. MONTROSE, Thursd[ay].

(Received via Belle Isle and Mont...

TO THE EDITOR OF "THE DAILY MAIL."

I am still confident Crippen an[d Miss Le] Neve on board.

of the Scottish established Church, Scotsmen were immune to the operation of the Clarendon Code, and being exempt from the restrictions of the religious Test Acts, Scotland was able to establish a flourishing export trade of university graduates to fill posts of influence, when English universities, whose standards declined steeply in the century before Test Act repeal, could not provide the necessary personnel. This circumstance sufficiently explains the unshakable, whimsical and still extant conviction among Scotsmen that education is a grand thing.

Within the limitations of a Mandarin tradition England has made susbstantial progress towards a conception of education *en rapport* with the democratic way of life during the course of the last generation, though Britain as a whole has still much to learn from the State universities of the Middle West. How far her southern neighbours trailed behind Scotland is evident from the following citation representative of the employer's viewpoint in 1807:

> "It is doubtless desirable that the poor should be generally instructed in reading, if it were only for the best of purposes—that they may read the Scriptures. As to writing and arithmetic, it may be apprehended that such a degree of knowledge would produce in them a disrelish for the laborious occupations of life."

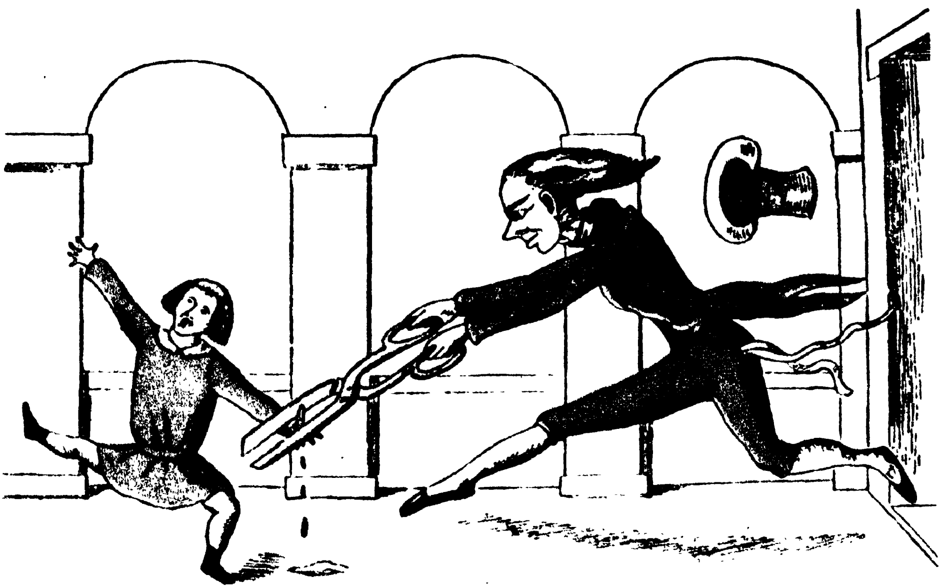
Professor Henry Hamilton offers us one reasonable account of the imposition of an incentive to daily reading as a habit of everyday life throughout a large and hitherto largely letterless section of the English community in the closing years of the nineteenth century:

> The working class were now politically powerful, and the newspapers of influential individuals and groups fought for their support. Alfred Harmsworth, afterwards Lord Northcliffe, was the first to sense the drift of changing conditions. His entry into journalism in 1885 marks the beginning of a new phase in the history of the Press. . . . Following the example of his first employer, George Newnes, founder of the weekly *Tit-Bits*, Harmsworth set out to capture the interest of the new public, whose intellectual attainments were those of the elementary school pupil. In 1888 he started the weekly *Answers to Correspondents*, and in 1896, along with Kennedy Jones, launched the *Daily Mail*. Its circulation rapidly rose from a daily average of 202,000 in the first year of its career, to 543,000 at the end of the third, a figure far in excess of any other newspaper. . . . Since the main source of a

IX *The rise of cheap printing, especially in color, was nursed by demands such as that for fashion catalogues. This engraving, published with descriptive text in "The Young Englishwoman" (1866), was printed in black and white and colored by hand.*

THE NEWEST FRENCH FASHIONS
Modelled for
THE YOUNG ENGLISHWOMAN
S. O. Beeton. 248 Strand London W.C.

X *Comenius had his followers among the early Victorians, but the quality of their visual aids, and their improving educational purpose, are already strange a century later. These, from a child's grammar published in the first half of the nineteenth century, were hand-colored.*



XI *"He that chastiseth one amendeth many." The virtues of chastisement, and the wages of juvenile sin, were publicised among children by artist and printer. (Above) Engraving by H. Heath, 1831, later hand-colored. (Below) Printed lithograph from a late nineteenth-century edition of Struwwelpeter.*

THE OLD MAN OF THE NAME OF TULKINGHORN

newspaper's revenue is advertisement, the paper with the largest circulation not unnaturally attracts the biggest advertisers. Papers with smaller circulations quailed before so formidable a competitor with no appreciation of the educative role a Press might play in the new age of a nation-wide reading public. The technique of the *Daily Mail* was different from that of its predecessors and contemporaries. It had an attractive form to catch the attention of those who wished to get news in short, snappy paragraphs and flaming headlines. News was not served raw. It was cooked, overdone, and heavily spiced.

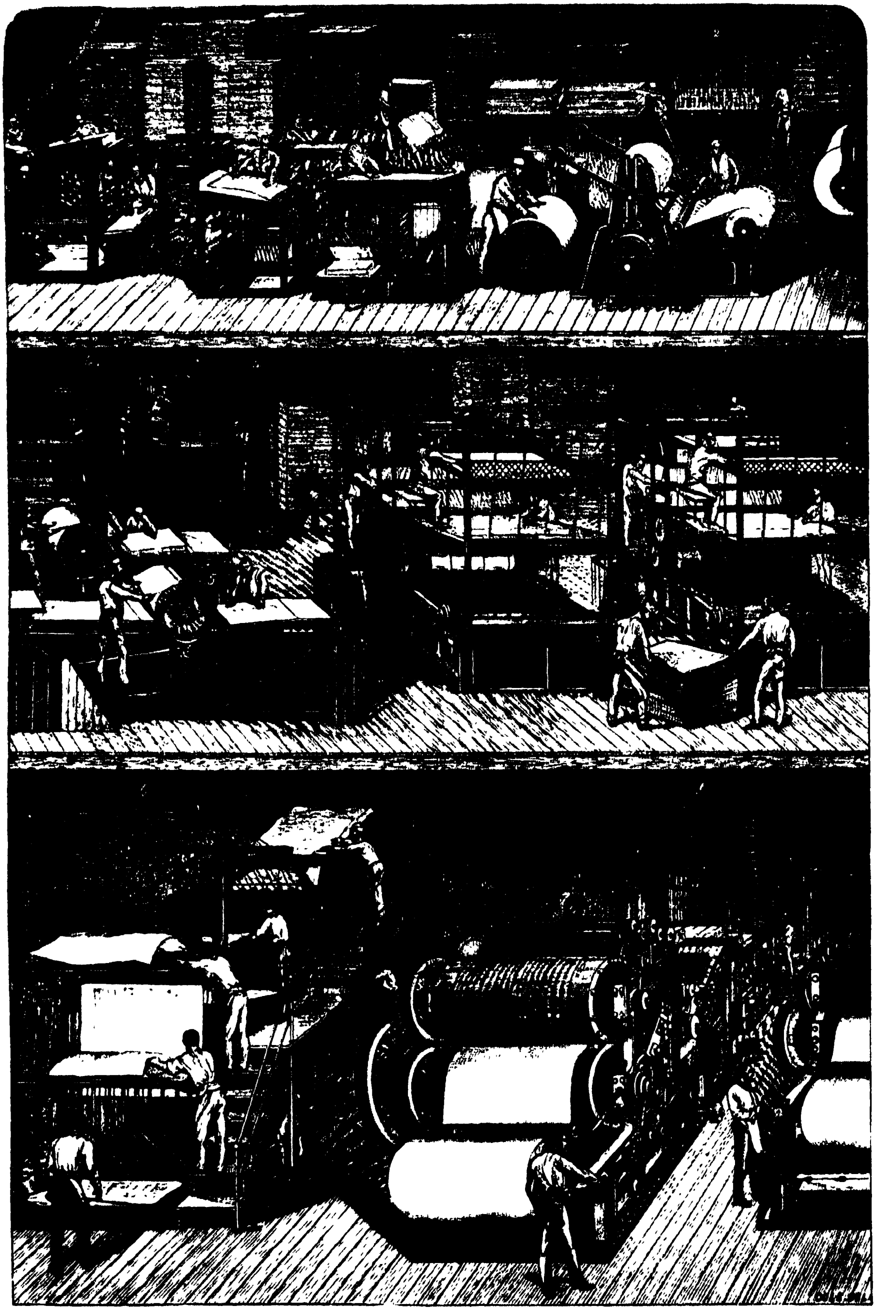
The emergence of the Press as an advertising medium with a working-class public has a special relevance to the role of the printer as illustrator, and other remarks of the author last cited in the same context bring us back to the same issue more explicitly:

Before 1900, newspapers had been for men only. In 1904 women were becoming a force to reckon with in politics, and Harmsworth started the *Daily Mirror* as a woman's journal. It soon established itself as a cheap picture paper. Four years later, Harmsworth (later Lord Northcliffe) achieved his greatest ambition when *The Times* passed under his control. Each successive year saw the tentacles of the great newspaper proprietors extend over the country. Printing and distribution of newspapers had become a highly capitalized industry, and the companies in control counted their capital in millions.

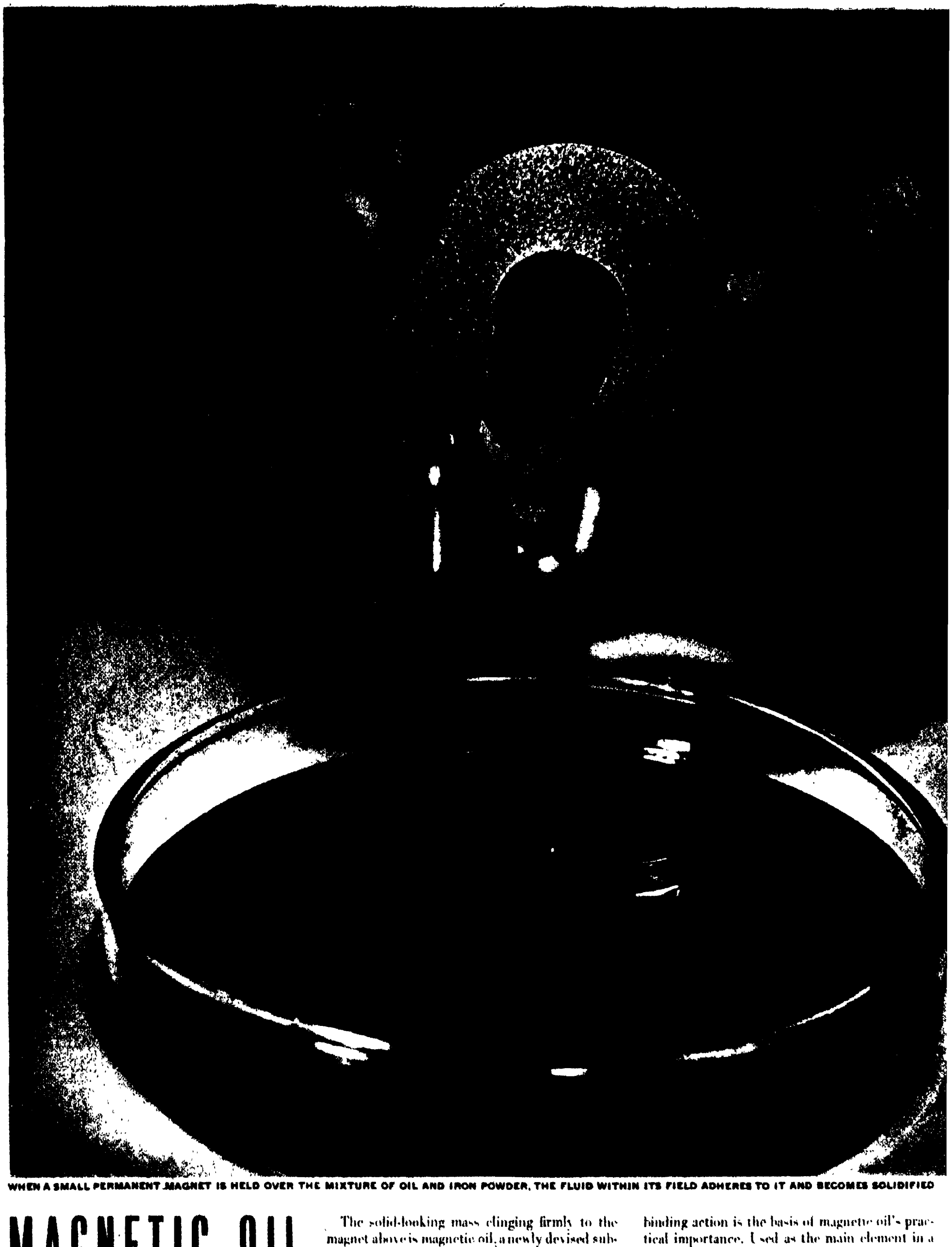
The significance of the pictorial newspaper and of illustrated commercial advertisement through the medium of a popular press resides in the fact that it forces on the daily attention of a personnel not as yet accustomed to reading long, or to reading often, as much written matter as the appetite can assimilate. That such a powerful instrument of education became available when and where its effect was most significant was a painless and inescapable consequence of technical advances in the art of printing during the lifetime of Dickens, himself a pioneer of the periodical press.

What the unprecedented sales of Charles Dickens owed to his illustrators and how a new market for illustrated books goaded his fertile pen into action is a well-thumbed brief; but our story would be incomplete, if we failed to take stock of the increasing popularity of illustrated books in the half-century before the linotype machine enlisted an appetite for sensation *en rapport* with a new time-consciousness in the habit of rapid and constant reading. The *penny dreadful* propagated the fiction-reading

XII *Illustrated books encouraged the demand for mass reading. The engravings of "Phiz", to which Dickens owed much of his unprecedented sales, were embellished with printed color at the turn of the century. (Frontispiece to "Bleak House".)*



89 *Pictorial journalism, which caught the interest of a public not yet accustomed to reading long, became, through the technical advances in the art of printing, a powerful potential instrument of education. A page from the "Illustrated London News" (1879) and a page from "Life" (1948).*

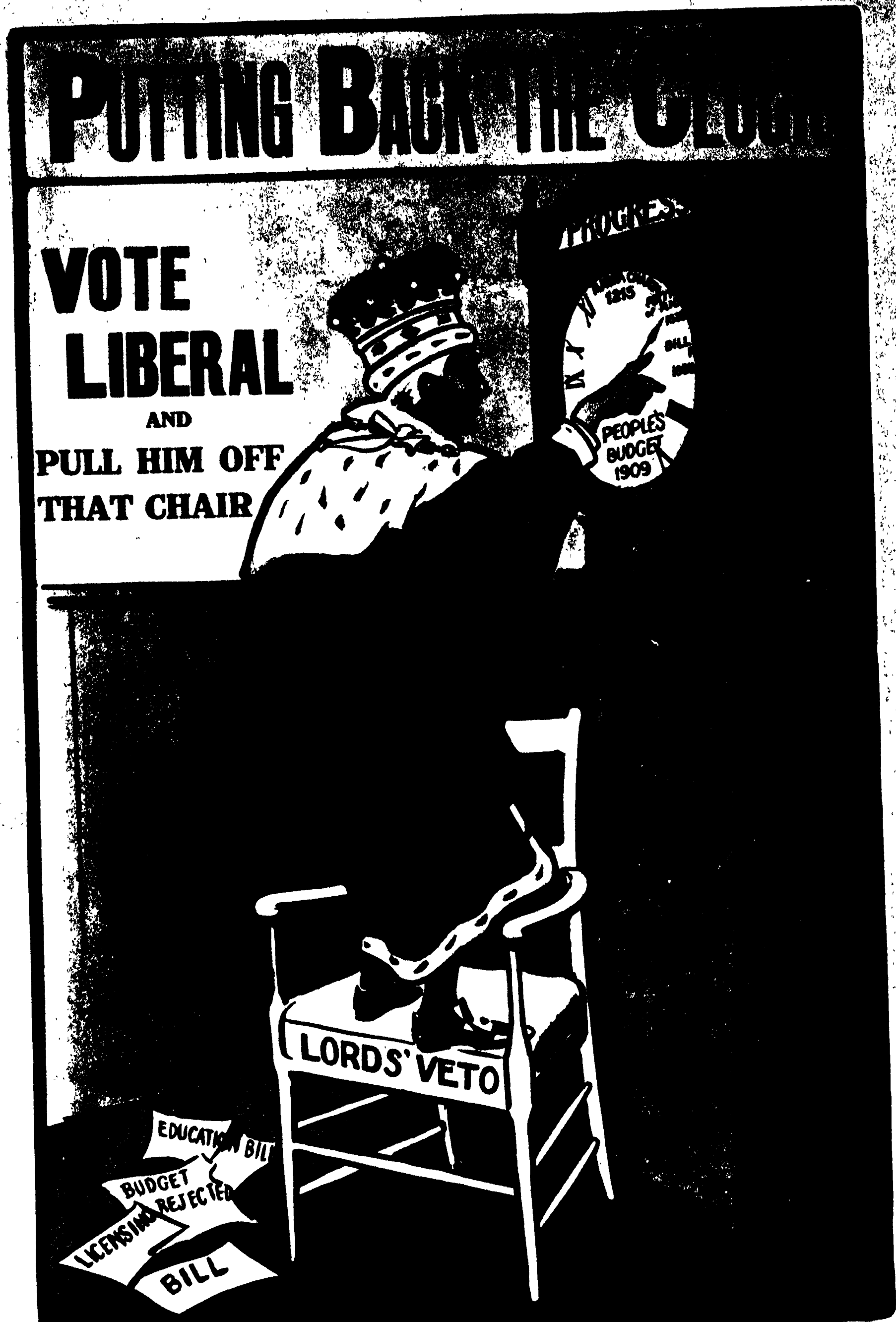


WHEN A SMALL PERMANENT MAGNET IS HELD OVER THE MIXTURE OF OIL AND IRON POWDER, THE FLUID WITHIN ITS FIELD ADHERES TO IT AND BECOMES SOLIDIFIED

MAGNETIC OIL

A new iron-containing mixture which solidifies when magnetized is basis of experimental clutch

The solid-looking mass clinging firmly to the magnet above is magnetic oil, a newly devised substance which promises to be of great importance in mechanical engineering. Made by mixing light oil with fine iron powder, the new fluid normally looks and feels very much like dirty crankcase oil. But when placed in a magnetic field, the thin liquid suddenly thickens into a tough semisolid. Its millions of microscopic iron particles become strongly attracted to each other and bind the fluid between them into a dense, homogeneous gel. This binding action is the basis of magnetic oil's practical importance. Used as the main element in a revolutionary type of automobile clutch invented by Jacob Rabinow of the National Bureau of Standards, it serves to transmit power smoothly from engine to wheels. When the oil is unmagnetized it permits the engine to turn independently of the wheels, as when the clutch is released in an ordinary car. When the magnetic field is turned on, the oil solidifies to connect the moving parts just as a standard clutch does when it is engaged.


PUTTING BACK THE CLOCK
VOTE LIBERAL
AND
PULL HIM OFF THAT CHAIR
PROGRESS
PEOPLE'S BUDGET 1909
LORDS' VETO
EDUCATION BILL
BUDGET REJECTED
LICENSING BILL

habit in the immature male age-group by investing it with the attractions of disapproval by parents who had some of them enjoyed the benefits of a prophylactic alternative. Such illustrated anthologies of moral maxims for the young antedate the Victorian parent by nearly a century. According to a genial essay by Janet Adam Smith, John Newberry, for whom Goldsmith wrote *Goody Two-shoes*, started the fashion in London when he set up as a publisher in 1744; but one may suspect that rich rewards for the publisher of bedside books for the bairns were few till Lewis Carroll hit on the formula. If the parent pays the piper, the parent must call the tune. Accordingly, a successful children's book will be one which parents can read aloud painlessly, the child's own enjoyment being less relevant to the content as such than to the amount of parental attention evoked thereby.

Among showpieces of a period which registers regulation of human life by the railway time-table, books for children have a fascination of their own, if only for the eloquence with which they vindicate the use of chastisement to a juvenile public, apparently unconvinced. It is a far cry from these edifying productions to the programme conceived by Comenius two centuries earlier; but it signalises a new source of profit for the printing trade with incalculable possibilities ahead. At least, it encouraged mothers of modest means to read, as did later another circumstance after cheaper paper became available. Patterns for home dressmaking, attributed to the husband of Mrs. Beeton of cookery-book fame, exacted the penalty of deciphering instructional print at a time when women of the artisan and lower middle classes had scanty educational opportunities. Commercial advertisement, especially fashion catalogues, and political cartoons, alike for reproduction and for exhibition at election times, are more notable precursors of a modern programme of education by visual aids, because they nursed a demand for colored reproduction at cheap rates.

90 *The Edwardian political cartoon, forcible in illustration, economical in language, also nursed the demand for cheap color printing. This poster played a part in the "People versus Peers" fight of 1909–10.*

McFADDEN'S ROW OF FLATS.

By E. W. TOWNSEND, Author of "CHIMMIE FADDEN."

Illustrated by R. F. OUTCAULT, - - - - - - Originator of "HOGAN'S ALLEY."

MARY ELLEN MURPHY: Mary Ellen Murphy, hasten quickly dear, and tell the Fresh Cop from Oak street to turn in a hurry ambulance call. And"—continued Mrs. Murphy, glancing up the street from [illegible]ndow—"and a fire alarm. Hasten quickly, darlint, brush your face, dear!"

[illegible]hat for?" demanded Mary Ellen; but just then [illegible] caught the amazing sight her mother, from her [illegible] lookout, had first discovered; and Mary Ellen uttered a whoop of joy [illegible] and up the street, yelling to the Dunnigan Twins, who were both [illegible] to sit on Congo's head, "Come on, youse. It's a circus, and a shoorder and a mad dog, and a fight!"

[illegible]ry Ellen's delighted announcement brought all the inhabitants of Tim [illegible]dden's Flats to their doors and windows. Truly it was a sight as [illegible] as it was enlivening. There came down the street from up Cherry [illegible] a procession, which warranted Mary Ellen in her description. The [illegible] was a shaved youth, arrayed simply in a sack of such yellow hue as [illegible] have excited the envy of Li Hung Chang. By his side pranced a knowing goat, sandwiched between two dogs, the three drawing a cart, [illegible]e-laden, and surmounted by a wonderful maid with a much more [illegible]rful hat. In one arm the yellow-clad boy carried a black cat, whose [illegible] youlings competed in the general racket with a bass drum and [illegible] horn. There was a girl near the yellow kid with hair of such redness [illegible] Congo, who was, until he saw her, only slowly reviving from his en[illegible] with the Twins, jumping high in the air when he first caught sight [illegible] radiant brightness. There were banners and flags and shouting and [illegible]ing; there were fights and laughter, and everything, indeed, calculated [illegible] the curiosity and enthusiasm of McFadden's Row of Flats.

[illegible] a no shoorder barty," said Kramer, the grocer, in high excitement. [illegible] a masquerade ball, already. Don't it, Kelly?"

Kelly, the barkeeper, for once had no opinion to offer. He was dumb [illegible] amazement, as was Ricradonna, the pushcart man. They could only [illegible] in amazement at the oncomers, and naturally join with Mrs. Murphy [illegible] the Ricradonna girls in a chorus of demands for Tim McFadden.

[illegible]e would know; nothing could happen in or near the Flats which Tim [illegible] not explain. There was comfort in that.

"Tim McFadden," cried Mrs. Murphy, "tell us what is this coming. Hasten [illegible]ly, Tim, for the love of heaven, and tell me what is this coming before I [illegible] out of this windy wid wonder!"

They gathered about Tim, who was standing on the stoop of his Flats, [illegible]ing proud and happy, but not excited. Tim's never that.

"My friends," said McFadden, "what you observe and hear coming down [illegible] street is a migration."

There was a moment's hush, until Mrs. Murphy called down to Kelly, the [illegible] keeper:

"Kelly, what's a migration?"

"A migration," replied Kelly, bound not to be again caught in ignorance, "[illegible] migration is a Raines Law Hotel—when it's pulled."

"Not so bad for you, my boy," assented McFadden. "The celebration [illegible]ing toward us now, which, by the same token, is now headed by the [illegible]nigan Twins and Mrs. Murphy's Mary Ellen, is the pick and flower of [illegible] Alley."

"I know [illegible] everything," interrupted Ricradonna. "Hogan's Alley is came in now moving out, and if you, Casey, haven't a care with the stove you are putting out of the window, you'll be having rifle to mend. The vacancies thereof, according by due process of law, will be filled, habituated and occupied by the ebrotine flower and pride of Hogan's Alley."

"I tell you bout dose ting," cried Ricradonna. "Tim McFadden is greate oratory dan dose Garibaldi. I second da motion to start hoora"—

"Murder alive!" broke in Mrs. Murphy. "What's this the Dunnigan Twins has betune thim? Is it a little Li Hoong Choong, or a kid wid the cholera, having the quarantean flag on him? Hasten quickly, Kramer, and inform me before I die wid worryment."

"Dose kid mit de yellow nightie?" asked Kramer.

"The same," Mrs. Murphy said—"the little one wid de shaved pate on him."

It was a proud day for McFadden's Row of Flats. All four of the Ricradonna girls came down to the sidewalk to join the Reception Committee, headed by Tim himself and including Mrs. Dunnigan, Kelly's wife and three children, not forgetting Congo, with eyes looking like two hard-boiled eggs, spotted with ink.

The procession swept into the block with a shriek and a cheer and a song and a hurrah. The Fresh Cop from Oak street looked

"I bid you welcome," he said to the newcomers, when the Fresh Cop had untangled a bounding ball composed of the Dunnigan Twins, the Yellow Kid, Mary Ellen and Congo, who were fighting for possession of the parrot. "I bid you welcome to McFadden's Flats by proclamation, all laws to the contrary being repealed thereof."

[illegible] scrap that fell [illegible] Mary Ellen wh[illegible] [illegible] and has a great eye for the main chance [illegible] the parrot, cage and all and tied the cage [illegible] Mrs. Murphy [illegible] when she makes a [illegible] with her growler.

The disturbance between Congo and the [illegible] Kid was called off temporarily [illegible] all [illegible] the [illegible] present a number of the members of his party [illegible] Flatters. He made them acquainted with [illegible] red-headed girl, Terence McSwatt and others [illegible] companions, who were distributed according [illegible] family connections in the recently vacated port[illegible] the Flat. There was no room or portion of a [illegible] signed to the Yellow Kid, but he discovered a [illegible]

FROM CAVE PAINTING TO COMIC STRIP 8

Back to Comenius from the Comics

Within the Anglo-American speech-community of to-day, and especially in Britain where paper shortage limits the publication of books with no assured prospect of sale, an author who writes at all does so for a reading public on both sides of the Atlantic. Mostly, this is no source of embarrassment to the author, especially when the British author can reflect with moral satisfaction on his dual contribution to the export drive after the Inland Revenue has deducted from his royalties everything except the fees of the accountant who arrives at a settlement of his indebtedness to His Majesty's Treasury. Still, the taboos of the sister cultures are not co-extensive; and there are two which no author can disdain without losing the good-will of his publisher. The British, or rather the English, veneration for cricket as a technique for propelling spherical objects around the landscape is one which puzzles other world citizens, even nationals of countries where there is a two-party system with a prospect of another innings for both; and it is no less true that the vogue of the Comic Strip in the contemporary American scene baffles any literate European, including the British.

Even in America the stupendous popularity of the Comic sometimes inspires sentiments akin to awe, as is evident from the following citation from an article by John Bainbridge in *Life* (14.8.44):

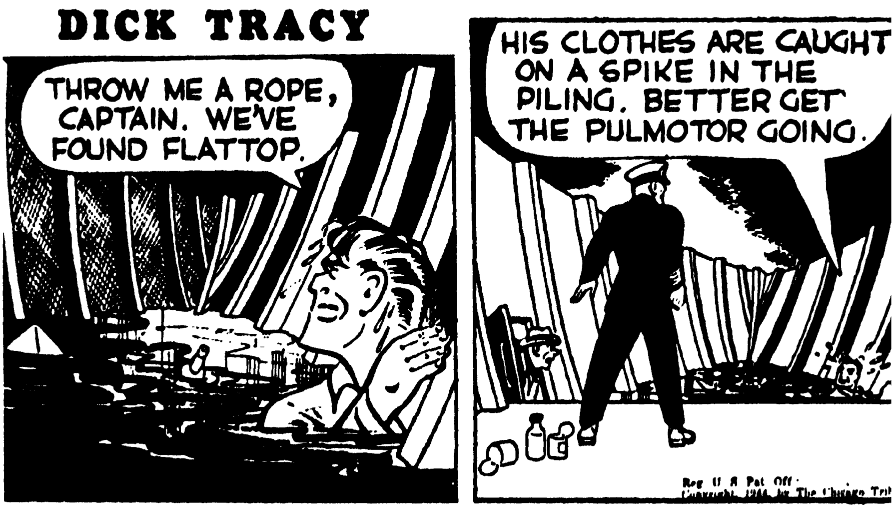
> ... Chester Gould, creator of the strip called *Dick Tracy*, must rank as one of the great writers of our time. ... He has a following far larger than any author whose books are featured on the best-seller lists. In recent months a consistent best-seller among fiction titles has been the novel *A Tree Grows in Brooklyn*. It has sold over 900,000 copies and been read, at a generous estimate, by 4,000,000 people. *Dick Tracy* is bought every day in the year by 13,500,000 people and is probably read by twice that number. Literary critics were ecstatic about the Brooklyn book, finding it, as one said, "profoundly moving". Although

91 *In 1896 R. F. Outcault's bald, flap-eared, precocious Yellow Kid, making his first appearance in the New York "World", marked the beginning of the Comic era. Newspapers had discovered that the public preferred pictures to words. Here the Kid transfers his baggage to McFadden's Flats and his allegiance to the "New York Journal".*

no literary critic, even in Brooklyn, has ever admitted being much stirred by *Dick Tracy* a few million other perceptive people apparently have. Recently . . . a *Tracy* character called Flattop died. As a large share of the population knows, Flattop was a dapper, dim-witted but appealing little killer who finally met his death by drowning. Having no relatives, he was buried in potter's field. The day before Flattop was laid to rest, Gould received half a dozen telegrams from people who offered to claim the body. "PLEASE EXPRESS FLATTOP'S BODY COLLECT TO ME AS BEST FRIEND", wired a man from Beaumont, Texas. The day of the funeral, several floral offerings and a stack of sympathy cards arrived at the office of the syndicate which distributes the strip. That night a crowd of bereaved citizens gathered in a bar and grill in Middletown, Conn., and held a wake, complete with a coffin and candles, for Flattop. Many people have since written Gould touching letters, expressing their deep sense of personal loss. "Two weeks ago my girl left me and married a sailor," an Army private wrote. "I just got over that, and then Flattop died. That upset me more than losing my girl." A woman living on the West Coast asked the ageless question, "Why did he have to die?" and added sadly, "All America loved Flattop."

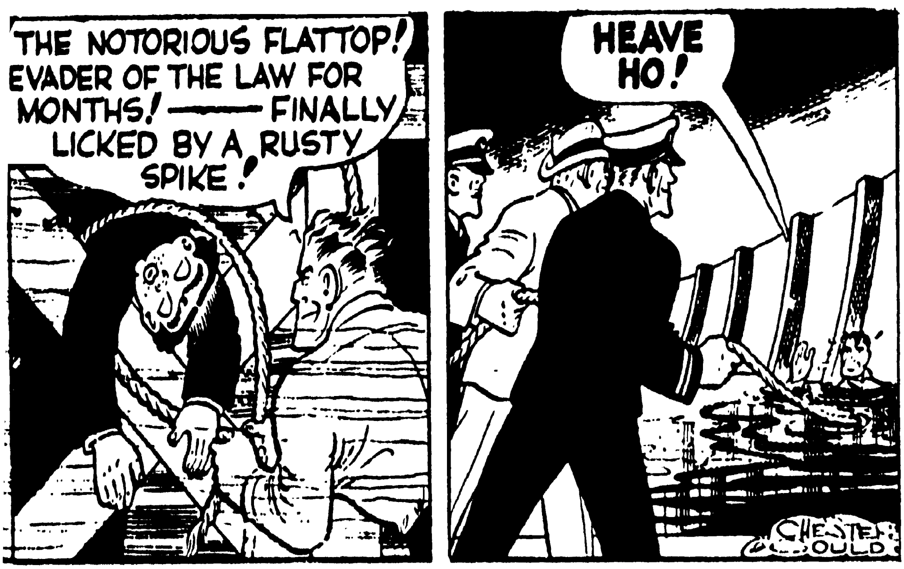
The writer respects but cannot claim to share the sentiments of the G.I.

92 *To-day 1,500,000,000 copies of comic strips appear in the American daily press each week, 2,500,000,000 each Sunday. Chester Gould's "Dick Tracy" alone claims more than 26,000,000 followers. When Gould's dim-witted, appealing little killer Flattop died, millions mourned.*



who felt the loss of Flattop more than the loss of the girl who married a seaman; but it would not be true to say that all Britain loved Flattop. Truth to tell, far more people in Britain have heard of Edison, T. H. Morgan, Millikan, H. J. Muller, or if it comes to that of Willard Gibbs and Smithson—to mention only a few names which have made these United States famous outside her own frontiers. None the less, Flattop, Flattop's ancestors and Flattop's progeny are a challenge to those of us who have one leg on either continent, as the author with two American grandchildren to his credit—or so he hopes. In short, the Comic Strip is a phenomenon demanding sympathetic examination by any born Britisher who hopes to understand the American people; and it is no easy assignment. One would be callous, if one failed to recognise that Flattop's decease brings one face to face with a great sorrow; but one would also like to be able to understand what all the sorrow is about.

To the Britisher, at least to the educated Britisher, the Comic is an enigma. To the educated American it is a *fait accompli*. Just as no American who refuses to come to terms with cricket can hope to understand the British, no Britisher who refuses to come to terms with the Comic can hope to understand contemporary American culture. The



93 *"Their emotional appeal is wish-fulfilment.... Superman is invincible, invulnerable. He can leap over skyscrapers, fly through the air and catch airplanes, toss battleships around, or repel bullets with his bare skin." The artist is Wayne Boring.*

writer, being English, is happily exempt from a moral obligation to interpret the soul of cricket to a continent which cannot participate in its spiritual message to mankind at large; but, being British, is constrained to make the effort of discovering the place of the Comic in the heart of the American public. It is at least an easier undertaking, and one which calls for no special knowledge of mechanics, meteorology or the psycho-pathology of the British tradition of compromise.

Happily, the expert sociologist has a recipe for such reciprocal understanding. The first thing to do is to get the statistics into focus. Happily also, the statistics of the Comics are more instructive than batting averages of Test Matches. William Moulton Marston, one of the Conquistadors of the Comic era, has set them forth in an article in *The American Scholar* (1943) on why 100,000,000 Americans read them:

> Eighteen million comic magazines are sold on the newstands every month. Since, according to competent surveys, four or five persons read each magazine, we reach the startling total of 70,000,000 or more monthly readers. Research indicates that nearly half these readers are adults.... Monthly comic magazine sales represent only the cream of the story-strip crop. Approximately 1,500,000,000 copies of four- or five-panel comic

strips are circulated every week in the daily newspapers. Only two of the nation's 2,300 sizable dailies—the *New York Times* and the *Christian Science Monitor*—are without comics. On Sunday morning some 40,600,000 children read 2,500,000,000 comic strips in more than 50,000,000 comic sections of Sunday newspapers, with far greater concentration than the progeny of our Puritan ancestors read the Bible.

Confronted with such astronomical figures, it goes without saying that we are in the presence of a social phenomenon which has enlisted contemporary talent in the creation of a literature of palaeography, hagiology, art criticism, social psychology and rural ecology. This is the verdict of social psychology on the Comics as pronounced by Marston himself:

> Their emotional appeal is wish fulfilment. . . . Superman is invincible, invulnerable. He can leap over skyscrapers, fly through the air and catch airplanes, toss battleships around, or repel bullets with his bare skin. Superman never risks danger; he is always, and by definition, superior to all menace. Superman and his innumerable followers satisfy the universal . . . desire to see good overcome evil, to see wrongs righted, underdogs nip the pants of their oppressors, and, withal, to experience vicariously the supreme gratification of the *deus ex machina* who accomplishes these monthly miracles of right triumphing over not-so-mighty might.

By and large, Marston's judgment ties up with that of the foremost historian of the Comic era. Coulton Waugh's opus takes off in the nineties, when the *genre* of—dare we say it—literature in the Apostolic succession of the Struwwelpeter saga had run its course in Germany. This formidably documented treatise summarises its triumphant progress in the Land of Promise as follows:

> 1896–1909. Comics began because modern newspapers had begun to cater to the great mass of people, and had discovered the public's love of pictures, rather than words . . . aimed, at first, at the kids.
>
> 1910–1914. The parents, reading surreptitiously over the kids' shoulders, began to find themselves grinning back from comic pages. It was a humorous and sarcastic picture of American suburban life, yet a picture of a prosperous period, which was presented. . . . These first readers were people connected with cities, and with such interests as golf, fishing, and marriage spats.
>
> 1915–1928. The development of nation-wide syndication began to carry the comics to the small towns, to the villages. The general form of the "funnies" remained unchanged: they were largely humor, largely pictures of family life. . . .
>
> 1929–1932. Came "Tarzan" and "Buck Rogers" and an abrupt change: illustrated suspense stories soon occupied one-half the space given to comics.

1933–1940. Came the comic book, and while it swamped the nation with sensationalism, it became gradually clear that here was one of *the most remarkable educational potentials* yet discovered in man's history [italics inserted].

1941–1945. Grew a preoccupation with grim reality in comic strips. High-lighted by "Terry and the Pirates" was an era of sophistication; the strips also absorbed the amazingly popular form of the radio soap opera. Laughter sank to a record low. People went about saying that the "funnies" would never be their cheerful selves again.

After V-E Day. . . . People wanted laughter again—and they got it. New strips burst out, nearly all of the old-fashioned gag type. The old form, it seemed, was still loved by most of the people. Another striking development was the emergence of Bobby Sox comics, which . . . showed a very steady and reasonable side of life.

From the same erudite source, we learn of the auspicious circumstances attendant on the birth of the Comic:

On February 16, 1896, when the readers of the New York Sunday *World* settled back in their crimson plush chairs and slacked their suspenders after dinner, they found . . . a three-quarter page in color entitled "The Great Dog Show in M'Googan's Avenue", and signed "Outcault". It was a kind of panorama of the city's slum backyards, filled with cats and wash and a lot of tough children in high-society costumes . . . very busy exhibiting their pets. These kids framed a central figure, a strange creature who, though evidently a boy, appeared to have passed through the major experiences of life in the first six months. Though small, he was important-looking. His head, bald, with flap ears, had a wise, faintly Chinese face, and he looked directly into the reader's eyes with a quizzical, interrogative smile. . . . The kid was dressed in a kind of nightgown on which was a smeary handprint, and this nightgown was colored a pure, light yellow. . . . "Hey, look at this," laughed the papas of New York. "Look at this, Emma, a yellow kid!" "Oh, George, that's so silly, it's only fit for the children." And Emma carried the funny section into the nursery. . . . These early experiments were far from being comics in the modern sense. A much closer ancestor, in the days prior to "The Yellow Kid", was the series, "The Little Bears and Tigers", funny animals which romped week after week in the San Francisco *Examiner*, beginning with the year 1892. There is nothing especially remarkable in the appearance of these little beasts to make them stand out from the many other gay and humorous drawings of the time. . . . The historic point about "The Little Bears and Tigers" is their regular occurrence, the fact that the readers made friends with them and, above all, that they appeared with the advantage of a large newspaper audience. The man who drew them, James Swinnerton, will be a mighty name in this history. He may be said to be the first of three founding fathers, who between them gave the comic strip the form in which we know it to-day; the others being Richard Felton Outcault, of the Yellow Kid, and Rudolph Dirks.

94 *The strip was known before the Comic era, in nineteenth-century Germany. "The Life and Deeds of Hercules" ("Münchener Bilderbogen", above), and Wilhelm Busch's "Heinrich" show the strong thread of cruelty which was to persist in Outcault's work.*

In sanften Schlummer eingewiegt
Der Herkules im Kissen liegt.

Im süßen Schlafe dehnt er sich —
Die Muskeln sind schon fürchterlich.

Da schleichen sich mit argem Sinn
Zwei Schlangen zu der Wiege hin.

Die hätten Herkulessen
Mit Haut und Haar gefressen.

Doch in demselben Augenblick
Faßt er sie Beide am Genick,

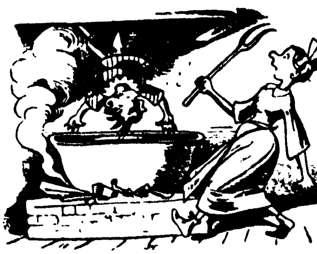
Und dreht die Hälse ihnen um --
Da liegen sie mausetodt herum.

Nun ging es nicht mehr lange her,
Da freut der Schnuller ihn nicht mehr.

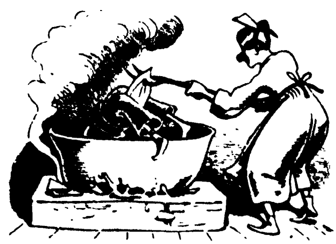
Als Knabe jung an Jahren noch
War Herkules drei Meter hoch

Sie fliegen dann, o weh, o weh!
Mit Heinrich fort und in die Höh'.

Hoch über seiner Mutter Haus
Da lassen sie den Heinrich aus.



Der fällt ganz schwarz und über Kopf
Der Mutter in den Suppentopf.



Mit einer Gabel und mit Müh'
Zieht ihn die Mutter aus der Brüh'.

95 *In 1902, Outcault's scale of values had changed with the times to Buster Brown's hot pranks, mellowing with the years to a nice gentility. But he was American, up-to-date, and jammed tight with that special quality of the comics, personality.*

Of these dignitaries, he whose labours are most instructive to a later generation was Outcault. His vogue was a nine days' wonder of the nineties, and is a high spot in Coulton Waugh's painlessly readable narrative:

Many of the characteristic forms of the modern newspaper had been created by Joseph

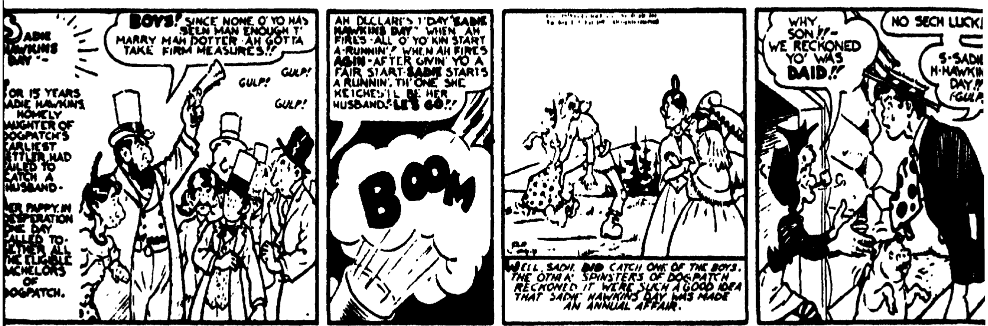
> Pulitzer. The New York *World*, by 1886, had become the most profitable and popular paper ever published. It was "affecting the character of the entire daily press of the country", as a contemporary writer notes. Not the least prominent of these innovations were the new color presses; and naturally, in this vintage year, 1896, Pulitzer's sensational colored supplement was a spectacle to set his rival publisher, William Randolph Hearst, into a red, white, and blue frenzy. . . . "—eight pages of iridescent polychromous effulgence that makes the rainbow look like a piece of lead pipe". So Hearst described his new comic section, the *American Humorist*. . . . Hearst had carried out this coup by means of an exceedingly simple and effective technique. He had bought out a big chunk of the *World* staff. Outcault and his Kid had moved to another floor of the World Building, into the Hearst offices. Pulitzer bought his staff back again, but Hearst again outbid him. . . . Pulitzer did not try to buy back his staff a second time, but he did not sacrifice his Kid either—there was no legal reason why he shouldn't find another man to go on with it. He found the painter George Luks. . . .

Of George Luks there is no need to say more than the eloquent obituary with which Coulton Waugh dismisses him. He never contrived to achieve:

> . . . the true, low-down vulgarity of Outcault. . . . Observable in Outcault's work, as well as in so much other entertainment of the period, was the strong, ugly thread of cruelty. In "The Yellow Kid's Great Fight", December 20, 1896, the Kid knocks down a little colored opponent and dislocates both his jaws. Then a goat butts the Negro and cheerfully pulls the wool out of his unfortunate head.

This then was saleable wish-fulfilment to the American public of the nineties; and it would be unsavoury to record as such, if the subsequent fortune of Richard Felton Outcault had been less sensitive to a continent in quest of a conscience. After the Yellow Kid came Lil Mose and, after Lil Mose, Buster Brown breaks well into a scale of values more attuned to the civilisation of the twentieth century, vindicating the Comic as part of the pediatric regimen of the modern American home. His predecessor, says Coulton Waugh, did not last long:

> Mose was an attractive pickaninny who did things like going out hunting with his animal friends and, in deference to their status, shooting at a target instead of living prey. . . . A change had come over Outcault's ideas, a new motive of tenderness. But this kind of thing was a bit of a strain on Outcault, who liked a good hot prank rather than a Sunday school lesson. Mose did not last long. On April 27, 1902, he took a donkey-ride in Central Park, and the donkeys, prophetically, threw him all over the place. We do not find him in the next issue of the *Herald*, his place being taken by a cross, capable-looking little boy dressed in absurd Lord Fauntleroy clothes. The page is entitled "Buster Brown's



96 *Finding a formula for pictorial wish-fulfilment is a life-and-death matter for every modern American editor. Al Capp's "Li'l Abner", a long, long way from the great city, is illustrated by the famous "Sadie Hawkins Day" strip.*

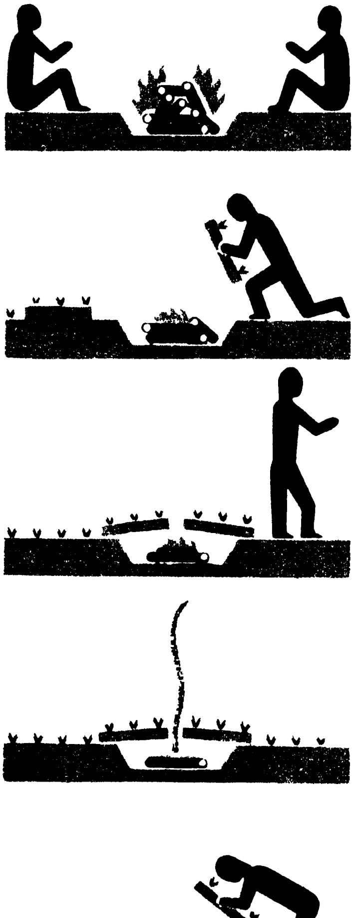
Bad Bargain".... Two months from the start, Buster suddenly comes into his true self, a guy with a shrewd, regular feller's soul, a hard business sense. He stands out from the other antiquated comics as being American, up to date, and possessed of that special quality of the comics, personality. Buster, like the Yellow Kid, was jammed tight with it. This was the secret of his fame, which spread with the true American enthusiasm of the period, until the whole flavor of a certain age of childhood was dominated by him. The details of Buster's astounding success are familiar to everyone.... After a few years in the *Herald,* Outcault moved Buster back to the good old New York *American.* Another Buster ran in the *Herald,* and, by 1906, we find both pages competing full blast. By this time the Busters had been so cleaned up that the pages were parlor products. They were clear and pale in color; "nice" children were able to read them without a blush. Before he was finished, Buster Brown was saying "Dee-lighted", in the best Rooseveltian manner.

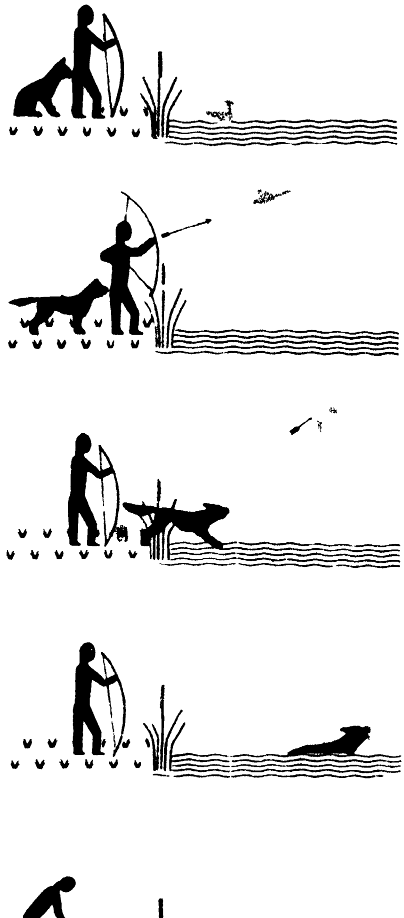
By this time the search for a formula for pictorial wish-fulfilment was a matter of life and death for the editor of any up-and-coming newspaper or magazine throughout the Union; and luck was on his side. Of such luck, the editor who first secured the services of Capp to feature Li'l Abner was the beneficiary. Russell Maloney tells the story of Capp's rise to fame in *Life* (24.6.46):

At the very beginning the whole *Li'l Abner* idea was nearly smothered in an avalanche

XIII *The entry of the psychologists produced "Wonder Woman", "a feminine character with all the strength of a Superman plus all the allure of a good and beautiful woman". The results were startling. "Wonder Woman" proved a forty-to-one favourite over her nearest male competitor.*


THE RUTHLESS CROOKS LEAP FROM THE CAR AS IT HURTLES FROM THE CLIFF.
JUMP!
APHRODITE HELP US! WE'RE FALLING OVER A CLIFF. STEVE AND THE GENERAL WILL BE DASHED TO BITS!
THE DAUNTLESS MAID DIVES, BEATING THE CAR TO THE WATER--
I MUST FIND A WAY TO SAVE THEM!
WONDER WOMAN SPRINGS UP FROM THE BOTTOM OF THE RIVER--
I HOPE MY PLAN WORKS!
WITH INDEFATIGABLE STRENGTH, THE BEAUTIFUL AMAZON CATCHES THE DOOMED CAR--
THANK APHRODITE, I CAUGHT IT!





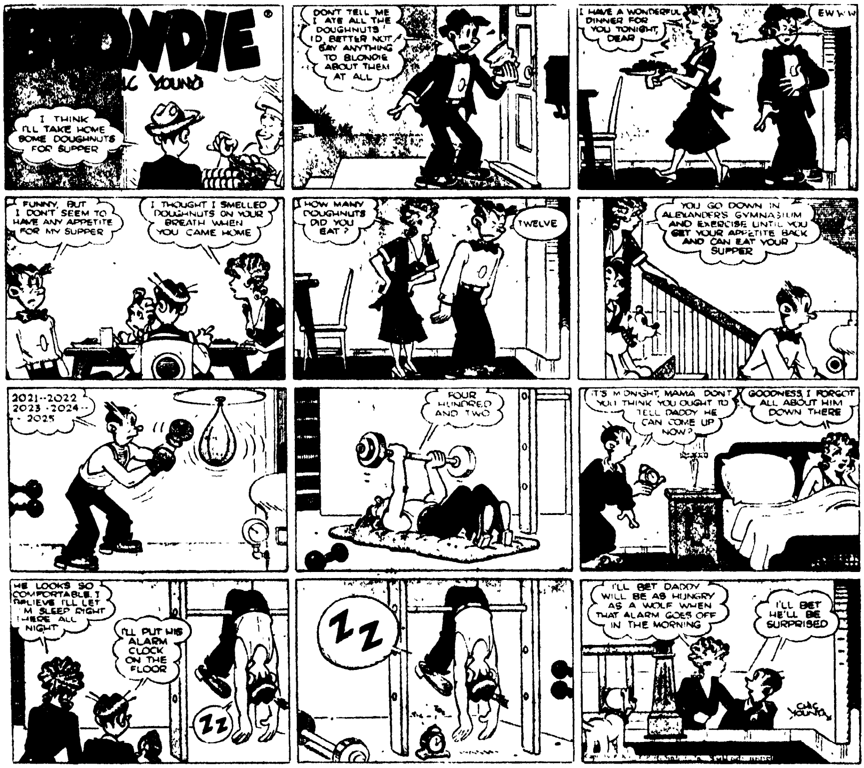
of good advice. The editor of one of the big syndicates received Capp kindly when he called, looked the sample strips over and said he liked them and was willing to put Capp under contract. "Just a few changes," he carelessly added. "Nobody's interested in hill-billies—better have this family living in Jersey or someplace near New York. Then, you might make the old mother sweet instead of comic, and for God's sake take that pipe away from her. The girl's fine, except for one thing—she hasn't got a job. Maybe she goes to work in an office in New York, and this Abner, he's in another office. . . ." United Features liked the strip as it was and asked him to start work the following Monday. At the end of the week Capp, acting out a fantasy common among wage slaves, told Fisher what he could do with his job. After a weekend of rosy day-dreams he reported to the offices of United Features, where he found that everybody was too busy to see him even for a minute. The syndicate had just secured the serial rights to Charles Dickens' *Life of Our Lord* and every newspaper in the country was bidding for it. "Come back after this blows over," a harried executive barked at Capp. "Wait two or three weeks." In order to subsist until the theological whirlwind should blow over, Capp had to go back to his old boss and strike up an ill-natured truce.

Happily for the distracted editor, crushed between the upper millstone of biblical scholarship and the nether millstone of worldly wisdom, there was in fact no single fool-proof formula. Some Americans were tired and some were bored. Some wanted adventure and the bright lights of the great city with all its temptations, others a shack a long, long way from it. Chic Young, described as "a lazy genius who forces himself to earn 300,000 dollars a year", created Blondie for the weary ones. "The charm which Blondie exerts", says Jack Alexander in the *Saturday Evening Post* (10.4.48),

> . . . seems to proceed from a wry twist which Young is able to impart to the everyday occurrences of family life which in themselves are not especially funny. Underlying most of the action, however, is a well-thought-out philosophy of fatigue. Young arrived at this philosophy by reasoning from the particular (himself) to the general (Dagwood Bumstead, the universal type), and he enunciates it soberly in the cautious thesis, "I think everybody is a little tired". It follows, he says, that if everybody is tired, everybody will get vicarious satisfaction out of seeing Bumstead relieve his own fatigue by eating, sleeping or soaking in the tub. This reasoning has been confirmed by high-domed surveys.

Meanwhile, the savagery and low-down vulgarity which Coulton Waugh records as characteristic of the Comic in the nineties could still find a market sufficient to provoke impassioned controversy among

XIV *Discipline of design, and a pattern of elements so familiar as to compel immediate recognition, make possible visual aids which can raise the educational level of the community. These two Isotype strips are from a visual history of early man.*



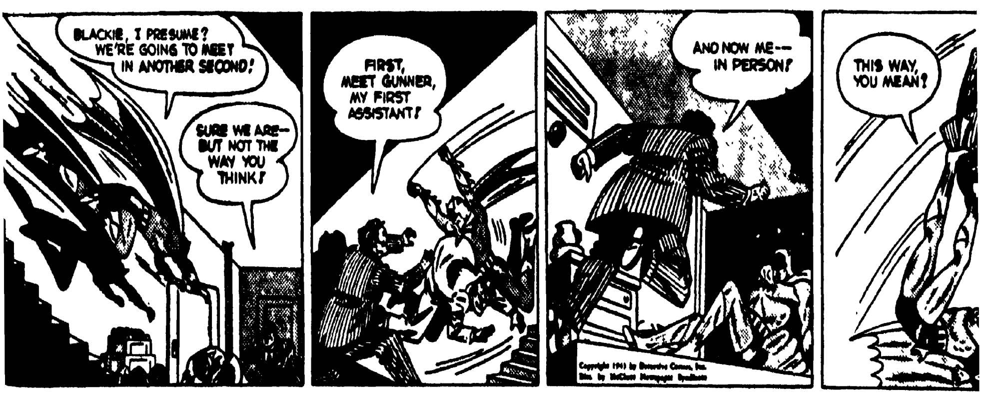
97 *Chic Young, "a lazy genius who forces himself to earn 300,000 dollars a year", created "Blondie" for the weary ones. Millions sin, suffer and sleep with Dagwood Bumstead.*

educators, moralists and psychiatrists. In *Collier's Magazine* of March 1948, Judith Crist expounds a view which presumably still claims influential support:

With eleven other psychiatrists and social workers, Dr. Wertham, senior psychiatrist for the New York Department of Hospitals and authority on the causes of crime among children, has spent two years studying the effects of comic books on youngsters. His findings, published here for the first time, constitute a warning to the parents of the nine out of ten American homes into which comic books eventually find their way. He got into the fight, Dr. Wertham said, "not as a psychiatrist, but as a voice for the thousands of troubled parents who, like myself, are concerned primarily with their children's welfare". The purpose of the study was to find "not what harm comic books do", Dr. Wertham said, "but objectively what effect they have on children. So far we have determined that the effect is definitely and completely harmful." The Criminal Law Section of the American Bar Association, which made a survey of publications for children, supports this judgment. Arthur J. Freund, chairman, reported, "While juvenile crime is on the increase in almost every locality in this country, the surprising circumstance is that the rate is not higher. However, the effects of the weakening of the moral codes and ethical concepts cannot be measured with any accuracy by crime rates or statistics. With almost every child and adolescent bombarded many times daily with the jargon of the criminal and the horrors and depraved methods of his activity, we should rejoice that we have as much normal and rational child behaviour as we do."

The horror *motif* which disturbs Dr. Wertham is not so easy to dispose of, being indeed sufficiently saleable to vindicate its own ethical credentials. Bob Kane claims that he designed the Batman—so Coulton Waugh tells us—to instil fear into the hearts of the underworld. Batman and Robin are eerie male figures, the one a hooded adult with pointed ears, the other a masked adolescent. It is difficult to decide whether Coulton Waugh is intentionally funny when they provoke him to comment: "why figures of justice should be hooded in the United States of America will always be a mystery to this writer. Our whole system is set up on the principle that we must respect our orderly, established processes of law."

98 *Bob Kane claims that the Batman was created to instil fear into the hearts of the underworld. A hooded adult with pointed ears, and a masked adolescent, are Kane's heroes in a tough world.*

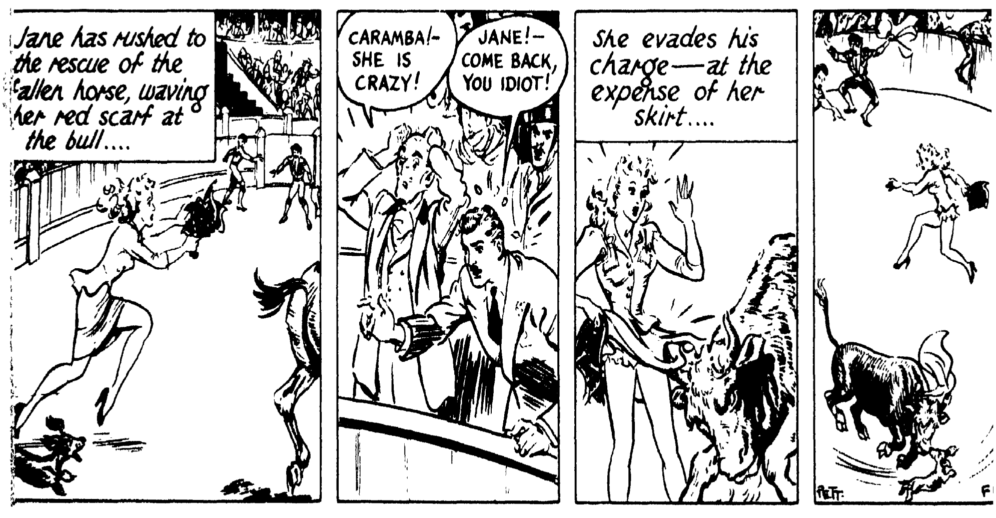


One presumes that the pioneer in the Higher Criticism of the Comic Strip is obliquely invoking the attention of his readers either to the failure of Federal Government to outlaw Judge Lynch or to a comparatively recent attempt of the orderly established processes of American justice to deal effectively with kidnappers and gang warfare.

It would be tiresome to scour the sacred texts for earlier and more vehement denunciations than that of Dr. Wertham. The Comic has thrived upon criticism, condemnation and contumely. Besides, a school principal who originated the now flourishing *genre* of publication devoted exclusively to the strip has shown his contemporaries a more excellent way. M. C. Gaines, the creator of the Comic Magazine, has successfully resurrected the *Heiligen* competitors of the fourteenth-century playing cards as *Picture Stories from the Bible*, thereby proving that earnest seekers after the kingdom of heaven have other things added to them, including the services of a high-powered team of psychologists.

Of such was William Moulton Marston, the father and willing slave of the *Wonder Woman*. Wonder Woman made her début in *Sensation Comics* at the beginning of 1942. King Features signed her up as a

99 *Jane, of the London "Daily Mirror", alluring, travelled, adventurous, has a wide following on both sides of the Atlantic—a "wonder woman" of another calibre.*



première paper-strip teaser two years later. At one time her syndicated magazine circulation was around two and a half million. Coulton Waugh's diagnosis of her miraculous birth and ascent into heaven is as follows:

> A psychologist, William Moulton Marston, was retained by the Superman-D.C. group of comics publishers to determine, if he could, ways of improving the quality of the comics then being circulated. He decided that the comics' worst offense was their blood-curdling quality; that a woman—since her body contains more love-generating organs and endocrine mechanisms than the male—would make the ideal protagonist for the strip of the future. However, the strong qualities should be brought out, too, and so arrived a new creation, a super-she, something wonderful, "Wonder Woman".

Apart from somatic details, this tallies with the creator's own account of his handiwork, as told in the *American Scholar*:

> My first sortie into the comics field was in the role of reformer. I was retained as consulting psychologist by comics publishers to analyze the present shortcomings of monthly picture magazines and recommend improvements. An advisory board of educators was formed for the "Superman-D.C." group of publications, including such outstanding authorities as Professor W. W. D. Sones, Director of Curriculum Study at the University of Pittsburgh; Professor Robert Thorndike of Teachers College, Columbia; and Dr. C. Bowie Millican, Professor of English Literature at New York University. The active efforts of these and others and the cooperation of the publishers, headed by M. C. Gaines and his associates, have raised considerably the standards of English, legibility, art work, and story content in some twenty comics magazines totalling a monthly circulation of more than 6,000,000. . . . It seemed to me from a psychological angle, that the comics' worst offense was their blood-curdling masculinity. A male hero, at best, lacks the qualities of maternal love and tenderness which are as essential to a normal child as the breath of life. Suppose your child's ideal becomes a super*man* who uses his extraordinary power to help the weak. The most important ingredient in the human happiness recipe still is missing—*love*. It's smart to be strong. It's big to be generous. But it's sissified, according to exclusively masculine rules, to be tender, loving, affectionate, and alluring. "Aw, that's girl's stuff!" snorts our young comics reader. "Who wants to be a *girl*?" And that's the point; not even girls want to be girls so long as our feminine archetype lacks force, strength, power. Not wanting to be girls they don't want to be tender, submissive, peace-loving as good women are. . . . The obvious remedy is to create a feminine character with all the strength of a Superman plus all the allure of a good and beautiful woman. . . .

Editors, publishers and colleagues were at first suspicious, says Mr. Marston:

> Didn't I know that girl heroines had been tried in pulps and comics, and, without exception, found failures? Yes, I pointed out, but they weren't *superwomen*—they weren't

superior to men in strength as well as in feminine attraction and love-inspiring qualities. Well, asserted my masculine authorities, if a woman hero were stronger than a man, she would be even less appealing. Boys wouldn't stand for *that*; they'd resent the strong gal's superiority. No, I maintained, men actually submit to women now, they do it on the sly.... Give them an alluring woman stronger than themselves to submit to and they'll be *proud* to become her willing slaves! M. C. Gaines listened to our arguments for a while. Then he said: "Well, Doc, I picked Superman after every syndicate in America had turned it down. I'll take a chance on your *Wonder Woman*!" ... I wrote Wonder Woman. I found an artist—Harry Peter, an old-time cartoonist who began with Bud Fischer on the *San Francisco Chronicle* and who knows what life is all about—and with Gaines' helpful cooperation we created the first successful woman character in comics magazines. After five months the publishers ran a popularity contest between Wonder Woman and seven rival men heroes, with startling results. Wonder Woman proved a forty to one favorite over her nearest male competitor, capturing more than 80 per cent of all the votes cast by thousands of juvenile comics fans. The credit is all Wonder Woman's—I mean the wonder which is really woman's when she adds masculine strength to feminine tenderness and allure.

Of his role as moral reformer, Marston writes in terms which recall the pictorialisation of *Diligence* and *Duty* in the seventeenth-century children's encyclopaedia of Comenius:

Feeling big, smart, important, and winning the admiration of their fellows are realistic rewards all children strive for. It remains for moral educators to decide what type of behavior is to be regarded as heroic. Shall we teach our children that the heroic thing, the deed for which they will attain desired kudos, is killing enemies and conquering their neighbors, *à la* Napoleon, Hitler, Genghis Khan, and others of their ilk? Or shall we make the great stunt in a child's mind the protection of the weak and the helping of humanity? The Superman–Wonder Woman school of picture-story telling emphatically insists upon heroism in the altruistic pattern. Superman never kills; Wonder Woman saves her worst enemies and reforms their characters.

It would be churlish to dismiss such engaging sentiments with cynicism; but it is permissible to ask whether the team of psychologists who have placed their services so devoutly at the disposal of the syndicated press have exhausted the educational possibilities of visual aids by disclosing a face-saving formula for wish-fulfilment *en rapport* with the conscience of New England. What is most significant about the Comic is not the fact that it is a mirror of the changing aspirations of a continent in which masked and hooded men can still defeat the ends of justice. For it would be true to say the same about any product of the printing press with a wide popular appeal. The challenge of the Comic is the stupendous popularity of the picture as a competitor of the printed word; and the reason why it is a challenge is that formal education still relies largely on the printed or spoken word as the medium of instruction.

Of how much American educationists have so far done to cash in on "one of the most remarkable educational potentials yet discovered in man's history", all Coulton Waugh can tell us is the sequel to the Gaines crusade for christianising the Comic strip. We learn that this redoubtable innovator has

> . . . produced a teacher's manual to go with Picture Stories from American History, one copy of which is supplied free to all teachers who have ordered a quantity of the books to use in their classrooms. This was written by Dr. W. W. D. Sones, Professor of Education, University of Pittsburgh, and Katherine H. Hutchinson of the Falk School of that institution. It contains highly practical suggestions for supplementing the comic books by maps and globes, by developing a "time scale" on the blackboard which will locate the events, constructing sand tables and so on. Each story is accompanied by such useful material.

Doubtless, this is good business for the Syndicates. A generous allowance for the undollared devotion of American educationists who have exploited contemporary possibilities for enlisting visual aids in the service of a liberal culture attuned to the era of hydro-electricity and atomic power, does not offer a sufficient explanation of the fact that European civilisation with no comparable commercial battalion of comic talent can offer America such salutary examples of the technique of pictorial instruction as Otto Neurath's *Modern Man in the Making*. If it is a platitude that America has given the world an object lesson in the popularity of the pictorial medium, it is also a truism to say that America has not as yet contributed to our common civilisation any outstanding vindication of its potential value.

The present writer does not lightly dismiss the use of visual aids as a device for stimulating an appetite for information easily surfeited by the printed word, especially at an age when there is no preformed habit of rapid reading to satisfy with intellectual advantage an eager curiosity too often and too easily blunted by intercourse with unsympathetic or ill-informed adults. Even so, the technique of the Comic defeats the end


IT RAINED ALL THAT NIGHT, AND NEXT MORNING, ELLEN CHANCED TO LOOK UP AT HEATHCLIFF'S WIDE-OPEN WINDOWS ..
HE CANNOT BE IN BED .. THOSE SHOWERS WOULD DRENCH HIM THROUGH! I'LL GO UP AND SEE FOR MYSELF!
ENTERING THE ROOM TO CLOSE THE WINDOWS, SHE RECEIVED A SEVERE SHOCK...
GOOD HEAVENS!
STARK DEAD!
SEIZED WITH A FIT OF TREMBLING, SHE CALLED OUT FOR JOSEPH...
JOSEPH, COME QUICKLY! THE MASTER'S DEAD!
JOSEPH SHUFFLED QUIETLY INTO THE ROOM...
THE DEVIL'S CARRIED OFF HIS SOUL, AND HE MAY HAVE HIS CARCASS INTO THE BARGAIN! WHAT A WICKED ONE HE LOOKS, GRINNING AT DEATH!
HEATHCLIFF WAS BURIED IN ACCORDANCE WITH HIS WISHES, NEXT TO THE GRAVE OF CATHERINE EARNSHAW. CATHERINE LINTON AND HARETON WERE MARRIED AND WENT TO LIVE WITH ELLEN AT THRUSHCROSS GRANGE. JOSEPH WAS LEFT ALONE AT WUTHERING HEIGHTS, AND THE ROOMS WERE SHUT UP, LEFT FOR THE USE OF SUCH GHOSTS AS CHOSE TO INHABIT THEM...
THE END

100 *The reaction of American educationists and parents to the cruelty and crime of early comics has produced not only "Wonder Woman" but also the moral teaching above. Even the classics are told in strips. (Left, last page of "Wuthering Heights.") But "one of the most remarkable educational potentials in man's history" is still to be exploited.*

in view, if such indeed were all that intelligent exploitation of visual aids could accomplish. What is far more important is that visual aids can make explicit to a vastly greater number of children and of adults knowledge of a sort accessible only to a minority with a special gift for abstraction, if the only method of imparting such knowledge demands sustained attention to a script designed to convey sounds people utter in oral discourse.

Right now, it would be possible to accomplish a revolution in the presentation of the fundamental principles of modern science and of such mathematics as is a necessary background to a genuine understanding of them, if we made this a number-one priority of educational policy. There is no reason why the whole of high-school mathematics should not be packed up in at most fifty wordless attractive wall charts with a puzzle *motif*, exhibited in situations which would daily invoke the constant and willing attention of the pupil; and one reason why there is little accomplishment to record of a project capable of speeding up the educational process in this way is not far to seek. The implementation of such a programme presupposes a visual discipline which is inconsistent with the co-existence of the Comic as a highly priced commodity in a culture dominated by the dollar incentive.

Up to a point, it may be possible to enlist successfully the technique of the Comic in the task of imparting instruction, or at least of awakening interest, in simple themes of national history or of social geography, inasmuch as they call for no considerable intellectual effort in any unfamiliar medium whatsoever; but a programme of instruction in the severer intellectual disciplines of the natural sciences or mathematics imposes a regimen of economy and restraint at variance with the itch for variety inherent in commercial competition to satisfy the fantasy-life of a syndicated public. If the end in view is to assist the apprehension of an abstract theme, there are two prerequisites to its realisation. One is to present a pattern of elements so familiar and so explicit as to compel immediate recognition. The other is to strip away from the situation everything likely to distract attention from the proposition which invites attention. Standardisation of conventions and simplification of form are indeed the basic desiderata of visual aids which can raise the intellectual level of a community. In its perpetual search for a novel formula of wish-fulfilment as an anodyne to reflection, the Comic has created an ideology of chromatic prodigality inconsistent with such discipline of design.

The impact of this ideology would be sufficiently paralysing, if there were not another powerful obstacle against exploitation of visual aids to encourage serious intellectual pursuits. In America, one can make an income, which no truly creative person could find time to spend, by selling to a publisher or to an editor a novel and genteel formula for the fantasy-life. Having done so, one can henceforth luxuriate in the satisfaction of raising the moral tone of the nation. A colleague who embraces the more exacting role of making an intellectually difficult problem accessible to the comprehension of a wider public has to choose between the thankless and menial task of writing a saleable text book or the more ambitious one of writing a successful work of popular exposition to provide a frame in which to hang the picture. Admittedly, popular science is not always unrewarding; but a whimsical convention exposes an author who himself executes 450-odd scale-diagrams* for reproduction by an illustrator with suitable technique of line and shading to daily requests for free reproduction. In short, it is too easy to amass an astronomical fortune by commercialising the picture medium; and it is the good fortune of America that British austerity does not lead the British educationist into temptation.

It would be unjust to close on a sustained note of criticism without due recognition of the existence of a vocal, if as yet ineffective, core of American opinion which regards with genuine and well-considered misgiving a product so characteristic of the American Century. If our strictures have been as colorful as our theme, we may confidently hope that the American reader will exercise the obligations of *noblesse*. After all, America is now rich enough to afford the luxury of laughing at its own limitations; and the high standard of contemporary American humorous writing which now mellows the austerities of the British milieu testifies to a sanitary readiness to do so.

* *Science for the Citizen* (Allen & Unwin, 1938).

FROM CAVE PAINTING TO COMIC STRIP 9

Serving Time, Saving Time and Showing Time

Education has now at its disposal far better means than his own generation for implementing the brave programme which Comenius outlined. This is partly so because of the dramatic development of then available devices for pictorial reproduction throughout the nineteenth century, more especially during the latter half of it. It is also so because we have in our hands to-day instruments of pictorial communication unforeseen in his time, and indeed in the lifetime of some now living. In this chapter, we shall see how this came about. In the next one, we shall consider more fully what use we can make of them other than as toys for tired people, as tonics to tempt a perverted appetite for ever more sensational news and as incentives to an ever more passive pattern of personal enjoyment among people who have relinquished the joy of craftsmanship for a material prosperity contingent on the mechanisation of the means of livelihood.

What is most novel about the Film and about Television as instruments of enlightenment is that they bring within the range of direct perception the whole gamut of scientific concepts which invoke the recognition of *time*—the mechanism of the clock, the motion of the celestial bodies, the vagaries of the gyrostatic compass, the development of the embryo. The static medium of the illustrated text-book can represent change and motion only by recourse to elaborate circumlocution and abstractions which lie beyond the reach of any but the few with a trained and facile imagination. Just as the invention of the zero symbol made the art of computation the common possession of the common man, the animated picture can now make *the dynamical content of modern science* a commonplace of the daily experience of all of us.

101 *Five centuries after Gutenberg the printed page can only suggest motion, even with the aid of stroboscopic photography. But the film and television have made it possible for the dynamical content of modern science to enter the daily experience of the common man.*

So far, we have taken little advantage of its essentially unique educational possibilities, though it is true that the film is daily gaining recognition as an indispensable, because time-saving, instrument of instruction. Within the Anglo-American speech-community, its chief effect on the everyday life of mankind to date has been an overflow of the exacting demand for punctuality contingent on mechanisation of, and travel to, the day's work into the leisure life of clock-stricken men and women neurotically staggering under a newly acquired burden of minute-conscious guilt. The picture palace imposes on us a time-schedule of passive leisure and a psychopathic urgency in the pursuit of vulgar and ephemeral novelty by the hypnotic impact of hyperbolic salesmanship which hails every new film as a masterpiece in the history of artistic creation. Here are some specimens from Roger Manvell's recent critique, set out in cold print without the dim light and the mass hysteria of the show to help the professional hypnotist in his assault upon our intellectual self-control and self-esteem:

> "It's fun and frolic, it's music and romance in a frozen paradise—but it's got sizzling pay-box temperature!" (*Iceland*).
>
> "A Story as lovable as *Mr. Deeds goes to Town*, as great as only a Capra, a Cooper, a Barbara Stanwyck can make it! While thousands sweep across the screen, drama reaches new heights and Capra achieves his finest production with a direct hit straight to the hearts of the world's leaderless legions of 'Little Men'." (*Meet John Doe*).
>
> "It's a scorcher! It's a sizzler! It's punch-packed with Melody! Comedy! Romance!" (*The Gay City*).
>
> "Paramount's up-to-the-minute Blitz romance—whirling from our bombed London to gay Lisbon!" (*One Night in Lisbon*).
>
> "A boy with a sock—a girl with a heart—a picture with a punch!" (*Knockout*).
>
> "The first picture to lay bare a woman's mind!" (*Shining Victory*).
>
> "Where men asked no questions—women revealed no pasts—no mercy expected!" (*A Man's World*).

Any night, any place, where there is a literate or semiliterate community of people who speak Anglo-American, it is possible to collect as many type-specimens of hysterical hyperbole from the trailers of forthcoming films. The puffs Manvell cites are not oddities. It would be easy enough to collect sillier samples of time-serving and sentimental sensationalism without going to Roger Manvell for source material; but it would be tiresome to do so. From a morbid arena of exclamatory punctuation and declamatory fatuity, we shall therefore seek sanctuary in the sanitary corridors of scientific endeavour.

We have already had occasion to mention the three-color process as an innovation made possible by a theoretical understanding of optical principles involved. For a comparable reason, the inventions with which we must here deal illustrate what is a highly novel characteristic of the culture of our own time. Before the eighteenth century, it would be true to say that practice had always been the pacemaker of fruitful scientific theory. The contributions of Newtonian mechanics to the solution of the pivotal problem of transoceanic navigation, leading to the inauguration of the British Board of Longitude in 1713, and the stimulus Black's work on Latent Heat imparted to a new phase of steam technology in the second half of the century, are premonitory of the emergence of a new profession and a new momentum of inventiveness; but it would still be true to say that chemical industry which started in Birmingham (1748) with the Lead-Chamber sulphuric acid process was the parent of the theoretical reorientation which begins with Dalton. As we approach the Atomic era, theoretical science assumes a new assurance begotten of success. Telegraphy, telephony and the dynamo are not the outcome of discoveries made in the workshop. They are by-products of the laboratory; and in large measure this is true of the four cardinal inventions which coalesce in the creation of the film. Each in turn registers a new freedom to experiment with a long-term end in view, a freedom born of fresh confidence in the rewards of giving scope to curiosity without demanding immediate returns.

First and foremost of the ingredients which go to the making of the film is the process of photography, itself the outcome of a confluence of techniques from different domains. To make a photograph two components are essential, a means of temporarily focussing an image on a screen and a surface which registers a permanent reaction to the image. The camera itself is a much earlier invention than the sensitive surface. In its time, discovery of the possibility of making an image by forcing light through a pin-hole was an incident of no mean importance to the

102 *The invention of the camera obscura in the sixteenth century supplied the first component required to make a photograph, a means of focussing an image on a screen. In this form, an aperture with a lens in it produces a reversed and inverted image of the object. In the eighteenth century, when this engraving was made, a portable camera obscura was a regular item of the artist's equipment.*

definition of optical principles; but this method of producing an image on a screen exacts the penalty of dimness. The use of a lens to achieve the same result without comparable diminution of visibility was a short step after the introduction of spectacles, and one with an immediately saleable application in the context of Dürer's age. The invention of the *camera obscura* as a tool in the hands of the artist-investigator, both to clarify the optical principles from which the new perspective school derived its rationale and to assist him in the discharge of his professional role as illustrator, takes us back to the middle of the sixteenth century, being commonly attributed to Battista Porta (1553); but we should properly regard it as the natural offspring of devices already familiar in the time of da Vinci. By the beginning of the eighteenth century the portable camera obscura is an article of commerce for sketching from nature, alike as a hobby and as a profession.

This artist's camera is one with a ground-glass screen on which it is possible to place a sheet of transparent paper to take the outline of the image by hand. Essentially, it is the studio camera of to-day before the photographer replaces the screen used to get the image in focus by a container for the sensitive plate or film. To capture the fugitive image itself, the first prerequisite is a material which undergoes a permanent change when exposed to light. That silver compounds, such as the chloride, darken on exposure was common knowledge among the alchemists in the second half of the sixteenth century, though the recognition of the essential role of light as the activating agent does not appear to antedate the observations of a German named Schulze in the decade 1720–1730. In 1802 T. Wedgwood, son of the great industrialist-investigator of the famous Pottery dynasty, following in the footsteps of his father who was Priestley's collaborator and patron, undertook experiments on long exposure of an image focussed on a film of silver nitrate on paper or leather. He did successfully obtain recognisable pictures without recourse to outline by hand; but they were not durable. Photography in the modern sense is realisable only when it is also possible to prevent the occurrence of further chemical change on bringing the hitherto unexposed, or relatively unexposed, part of the image into the light of day.

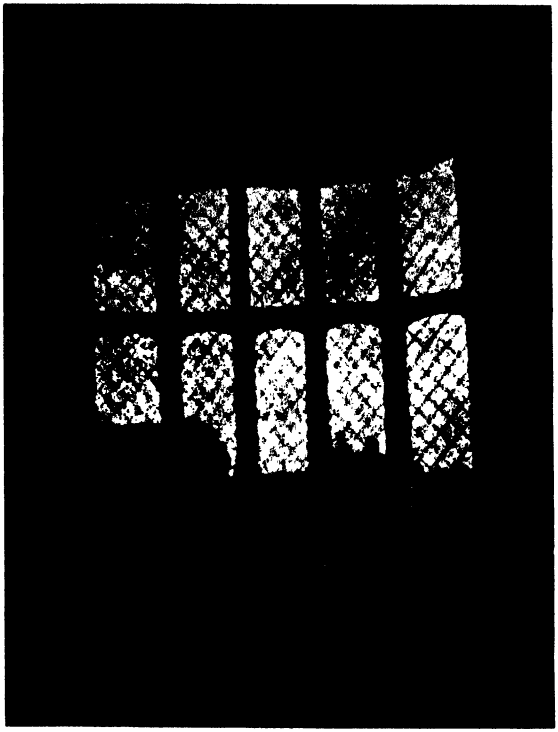
It seems that Niepce (1765–1833) and his co-worker Daguerre (1787–1851) were the first to solve the problem of fixing the image. Niepce was a keen lithographer but a poor draughtsman, Daguerre a painter with a lively interest in light and shadow effects. They were not laboratory scientists but the impetus of their efforts was effective only because laboratory chemistry was now on the wing. Lithography did not start till the end of the last decade of the eighteenth century. Niepce took it up in its infancy, when lithography was far better adapted to take direct advantage of the camera obscura than was the older process of engraving. There was therefore a new technical incentive to exploring the possibility of fixing the image *in situ*.

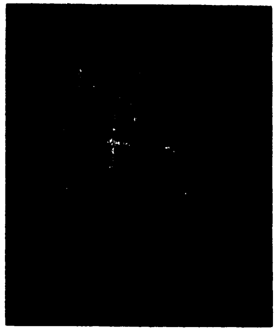
Niepce and his brother Claude found, or made use of the fact, that prolonged exposure to light makes *asphaltum* resistant to its usual solvents. After focussing for several hours an image on a glass surface with an

103 *The second component required to make a photograph, a means of fixing the image, was discovered by Niepce and Daguerre. The latter used mercury vapor to develop the image on a copper-plate treated with iodised silver. A photograph of the earliest known daguerreotype (1837) is shown above.*

adherent film of asphaltum not previously exposed to light, it is therefore possible to wash away the relatively dark part of the field; and the transparent copy of the image so obtained is then available for etching. In 1922, the French Photographic Society celebrated the centenary of the success which crowned the experiments of the brothers, and on that occasion the President stated that 1822 saw the first durable photographic reproduction, a picture of Niepce's own house on a tin (or pewter) plate.

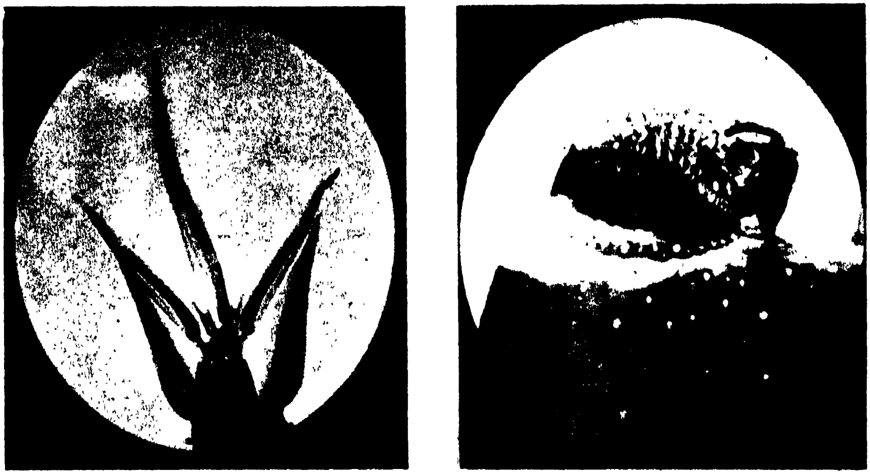
 Daguerre's interest in light and shade led to the *diorama*, a curious





104 *Daguerreotypes could not be multiplied, but Fox Talbot succeeded in obtaining negatives on paper, and later in printing positives from them. A photograph of his first negative (approximately self-size on black background, 1835) is shown above (right), and (left) an enlargement of a print from it.*

invention of the early nineteenth century with some anticipation of the cinema but no direct connexion with photography. In 1829, he went into partnership with Niepce; and they worked together in the search for a light-sensitive substance more suitable than asphaltum. The next step was one of those happy accidents which occasionally reward the obsessional type. One day, Daguerre left a silver spoon on an iodised silver plate; when the spoon was removed, it was found to have left its design on the plate. For a long time Daguerre failed to get images on



105 *Science was not slow to use the new medium. The moon shown opposite is a photograph of a daguerreotype taken by Draper in 1840; the photo-micrographs above were taken by Clarke in 1887. By this time Scott Archer had discovered his wet-plate process, in which a film of collodion held the chemicals on a glass plate. A collodion photograph by Delamotte (1855) is shown opposite.*

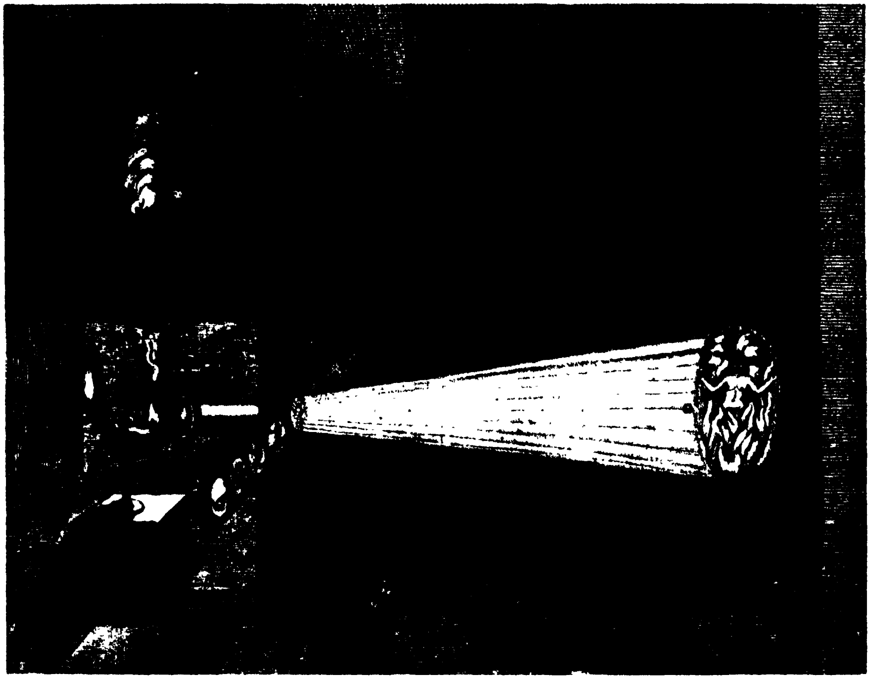
such plates when he tried exposing them in a camera; but in 1837 (after Niepce's death) he put away in a cupboard some iodised silver plates, which he had been experimenting with. Later, he found that an image had appeared on one of them with a clear definition; and further investigation showed that the developing agent had been mercury vapor from a bowl of mercury in the cupboard. This vapor had acted on the plate, as breathing will act on a window-pane to make a tracing appear. Daguerre then found that he could fix his images with a warm solution of common salt, for which Sir John Herschel later provided a better alternative—sodium hyposulphite—still in use.

In 1839 Daguerre persuaded the French Government to buy his process. He then divulged it to the French Academy; and it was henceforward at the disposal of all nations. While it was still a secret process, an Englishman had already produced pictures in a camera and had fixed them by a method essentially similar to the Daguerre technique. Fox Talbot, such was his name, had visited Italy about the year 1834 with a camera obscura to obtain sketches from nature. Like Niepce he was himself a poor

draughtsman with a good reason for wanting to get his image cheaply. He gave a full description of his process to the Royal Society in February 1839. At first he tried to fix an image by using paper impregnated with silver chloride; but after five years' work had success with silver nitrate–silver iodide paper. Success came through the discovery that the invisible impress made by *short* exposure to light on the silver component could be coaxed into recognition by treatment with gallic acid. Of itself, this was a great advance over the method of making the *Daguerreotype* metal image. It was now possible to develop the image after exposure for about a minute instead of an hour; but the *calotype*, as he named the product, would have remained a tool of the engraver or lithographer, if he had not succeeded in taking a decisive step further. He had first obtained negatives from which it was possible to transcribe an image for illustrative reproduction; but he pursued the new clue till he could also make positives by printing on silver chloride paper. By 1850 photography was thus a self-reproductive process and as such a new tool of communication.

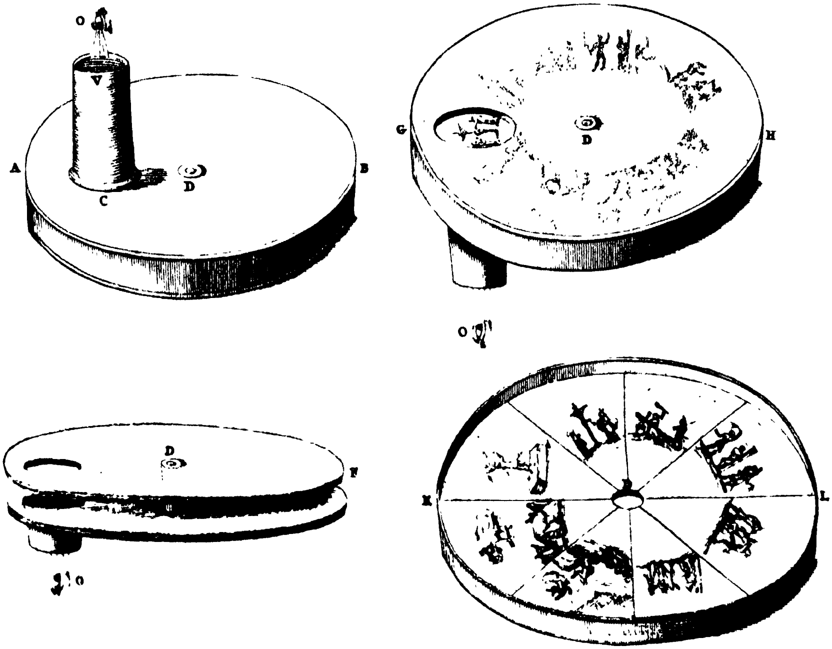
Photography found its first commercial use in the context in which it arose as the handmaid of the illustrator's art through the patronage of the printing interest. Soon *Daguerreotypes* were on sale to an alternative market, and how soon scarcely calls for comment. We must now retrace our steps to find the origin of the ancillary technique of *projection*. Of the four cardinal inventions which coalesce to give us the cinema, the one whose affinities and uses lie closest to the photographic art is the *magic lantern*. Its invention was not an outcome of singular originality in a century already familiar with the camera obscura. *Ars Magna Lucis et Umbrae* published in 1646 by a German Jesuit called Athanasius Kircher describes the first on record, complete with source of light, reflector and lens, to exhibit on the wall of the Jesuit College in Rome images of devils, demons and skeletons painted by hand on glass slides. In the same book, Kircher describes a device which may have contributed to the construction of the zootrope to which we shall come later. He knew how to change

106 *The modern camera has been adapted to many specialised uses. Its efficiency is illustrated by this high-level reconnaissance photograph of Cologne, taken on film under war conditions in 1943.*



107 *Projection was first described by Athanasius Kircher in 1646. His lantern (above) was complete with source of light, reflector and lens; it cast an image of hand-painted glass slides. He knew also how to change his pictures quickly by painting them on a revolving glass cylinder (right).*

his pictures quickly by painting them on a revolving glass cylinder. A few years later, a French Jesuit, de Chales, improved the design of the Kircher instrument, or possibly invented a better one without knowing about it. Early in the eighteenth century, a Dutchman named Musschenbroek made it more adaptable to secular showmanship by using two superimposed slides, one fixed to show background, the other movable by a cord. In this way, it was possible to suggest motion in a primitive way, as for instance a shower or rain, a storm or lightning. During the eighteenth century the lantern thus had a popular sideshow vogue as a device for producing phantasmagoria; and some give the French physicist



Charles of balloon fame credit for trying it out as a visual aid in the classroom. Be that as it may, the craze came to an end when the novelty of its limited uses began to wear off. To go places with the magic lantern, the showman needed two auxiliary inventions. One was the electric carbon-arc, to assure a sufficiently bright image of entities other than devils, ghosts, skeletons and things that go bump in the night. The other was photography to reproduce the material source of the illusion as a saleable product, and to multiply without limit topics to project upon the screen.

By the time both possibilities were realisable, optical showmanship had nursed a public appetite for novelty by other means. One such was Diorama, already mentioned in connexion with Daguerre. Diorama was a visual vanishing trick in a darkened chamber equipped with lighting devices controlled to make one or other painting on the same translucent sheet visible or invisible by differential illumination of the

"HOW WONDROUS ARE THY WORKS, PARENT OF GOOD."

AT THE

ROTUNDA, DUBLIN.

Messrs. Keevil

[illegible]

TWO POPULAR LECTURES

ON

ASTRONOMY,

And One on the **POLARIZATION OF LIGHT,**

ON THE EVENINGS OF

Thursday, the 26th, Friday, the 27th Nov., and Tuesday, the 1st Dec

AND

A condensed Astronomical Lecture

Will be delivered on Tuesday Morning, the 1st December, commencing at One o'clock, followed by an Exhibition of the Diorama.

THE ASTRONOMICAL LECTURES WILL BE ILLUSTRATED BY

The Largest Orrery

IN THE KINGDOM!!

[illegible]

THE SOLAR SYSTEM,

[illegible]

THE FIRST EVENING'S LECTURE

[illegible]

THE EARTH'S MOTION

[illegible]

Hindoo Pantheon and Temple of Isis in Egypt.

THE SUN

[illegible]

THE MOON,

[illegible]

The Orrery each Night.

THE SECOND LECTURE

THE TIDES

[illegible]

The Eclipses of the Sun & Moon,

[illegible]

COMET OF 1680, &c.

[illegible]

The Third Lecture will be delivered on the Evening of Tuesday, 1st Dec.

ON THE

POLARIZATION of LIGHT,

[illegible]

The principal Phenomena of Polarization,

[illegible]

HYDRO-OXYGEN POLARISCOPE, &c.

[illegible]

[illegible]

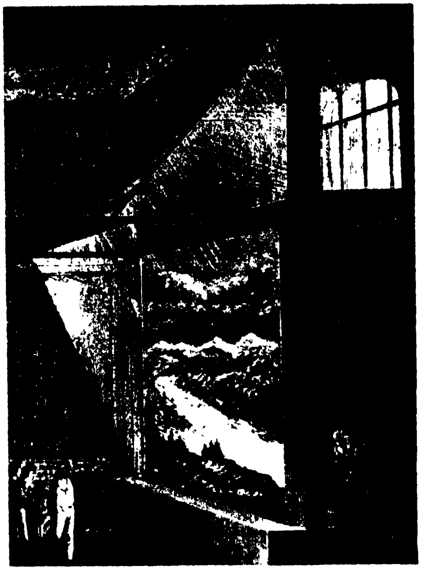
DIORAMA,

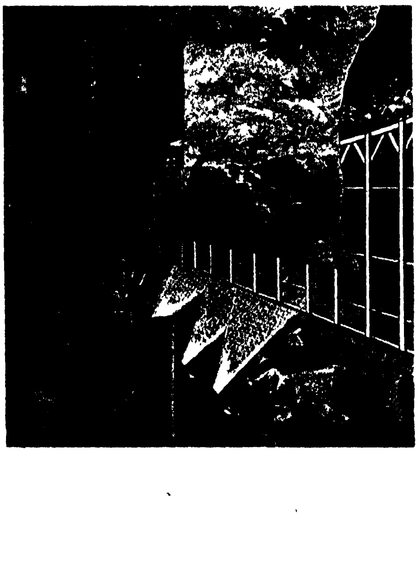
OR DISSOLVING VIEWS,

Consisting of upwards of Five Thousand Square Feet of Canvas,

ILLUMINED BY HYDRO-OXYGEN GAS.

[illegible]





two sides. Other novelties signalise the exploitation of the introduction of gas as a source of illumination in the opening decades of the nineteenth century. When photography became available, the missionary motive which seemingly upheld the zeal of the inventors of the lantern itself coaxed a more rapacious appetite for optical illusion and forestalled any danger of surfeit.

The nineteenth century witnessed a considerable growth of geographical knowledge through colonisation and imperialist expansion of continents hitherto known only to seamen and to merchants, if known at all. In Protestant countries—especially Britain, then foremost in the scramble for territorial acquisition—missionary enterprise, hitherto relinquished by Calvinists to their Jesuit competitors, suggested a new way of sweating moral guilt out of the body politic. British non-conformity was now predominantly Methodist and as such in opposition to the Calvinistic prejudice which excluded the Sons of Ham from the compensations of predestined grace. Also, Methodist leaders of the textile industry and the printing trade could reap substantial profits from the liquidation of nudity and the provision of free Bibles distributed by public subscription. In this setting, missionary enterprise became a ruling passion of Victorian Britain; and the magic lantern, as an instrument to exhibit the depravity of the heathen with an attractive scenic background of geographical information, became the means by which Providence loosened the purse-strings of potential but reluctant subscribers to the mission funds. One outcome was that it was now necessary to purge European history of any reference to the contributions which the Chinese, Hindus and the Moslem world made to our common civilisation. The British fever for missionisation, sustained by Gladstone's Turkish policy which made every mishap to the Armenians hit the headlines as a massacre, sufficiently accounts for a peculiarly British fantasy about the role of the Byzantine refugees in the great enlightenment which followed the beginning of printing from movable type in fifteenth-century Europe.

108 *Daguerre's diorama for showing "dissolving views" (above) became one of the tricks of optical showmanship which were good box-office in the nineteenth century. (Below) Wooden Valkyries, a gauze screen and hidden lanterns which projected the moving clouds provided a spectacle at the Paris Opera (1893) in which it was "impossible that the illusion could be more perfect".*

Besides, the lantern offered a consecrated alternative to the carnal attractions of the theatre and the circus, as the *Heiligen* had offered a counter-attraction to the playing cards of the first wood-block printers. If it enjoyed a minor vogue as a visual aid to geographical education outside consecrated ground, when and where the globe-trotter could find a secular audience, the chapel could rely on its secular uses to drive home to a wider public the unhappy and unwholesome lot of continents as yet without the means of salvation. In short, there was an eager public for projection when the technique of animation was approaching a climax with stupendous possibilities for the investor, who could entertain hopes of earthly reward unhampered by a pre-existing prejudice against the theatre as the littermate of the brothel.

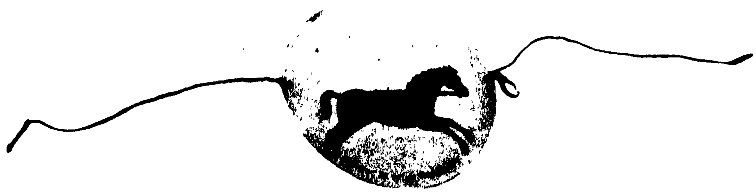
Missionary enthusiasm thus contributed no little to antenatal care of the maternal lantern during the period of gestation while the technique of photographic animation was itself in a foetal stage. Another outcome of relevance to the romance of human communication has been the subject of comment in "The Arrival of the Alphabet". The labours of devoted and scholarly men and women with little encouragement from government and no incentive of worldly reward carried the printed word to letterless peoples of the Dark Continent and laid a solid foundation for a world programme to liquidate illiteracy and unify mankind on a global scale.

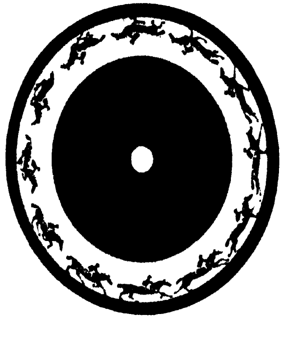
There were two prerequisites of Animation. One was a material more flexible than glass for recording a sustained succession of images; and this was the last step. The other was a physical method of creating the illusion itself. Illusions, including those which we now attribute to the persistence of impressions on the retina, had excited comment long before the time when Ptolemy's experiments on refraction furnished a clue to the hoary conjuring trick of making a penny on the base of a vessel come into view by filling the latter with water. Indeed, we cannot read aright the classical controversies about appearance and reality, unless we realise what bewilderment such optical enigmas evoked among the wiseacres of antiquity. The problem of persistence was one which later fascinated da Vinci, and Newton himself used rotating discs with segments of different colors in his experimental researches on the structure of white light. It was

109 *In Victorian England the magic lantern came into its own as an instrument to exhibit the depravity of the heathen, against attractive backgrounds of icy mountains or coral strands. In the crowded intimacy of the family party it seems to have foreshadowed the slapstick of the early film.*

thus in the tradition of the founders, when Roget (of the *Thesaurus*) read a paper to the Royal Society (1824) entitled *Persistence of Vision with regard to Moving Objects*. Roget's interest started from a chance observation of the revolution of a cart wheel through a Venetian blind. About the same time, Wheatstone (of Wheatstone's Bridge), also notable for his role in the invention of the stereoscope, announced the discovery that "a series of brief illuminations make it possible for a moving object to seem immobile".

In 1826, a new toy called the *Thaumatrope* was on sale. It was a disc with strings for twirling it. One half might carry a picture of a bird-cage, the other a bird upside down. If you twirled the disc slowly, the bird was outside the cage, if fast enough, it seemed to be inside. Other favourites were the horse and the rider, the rose-bush and the garden pot, a branch





110 *The problem of animation was still to be solved before the moving picture was possible. Many nineteenth-century optical toys took the first step by fusing successive images on the retina faster than the eye forgot them. (Bottom, right) Zootrope; (top) frieze for use in zootrope; (centre) two thaumatrope discs; (bottom, left) Eadweard Muybridge's zoopraxiscope disc.*

with and without leaves; two parts of a word or a letter. In the thirties of the nineteenth century, this toy proved to be the parent of a crop of patents variously and grandiloquently called phenakistiscopes, stroboscopes, zootropes, and the like. Herschel, Plateau, Faraday, von Stampfer and other physicists had a finger in the pie, and the toy trade discovered that science pays. The zootrope is a cylinder like a cake tin, able to rotate on a vertical axis, with slots for pictures successively showing the same object with slight changes in the relative position of its parts. When it rotates, the fusion of the images through the retinal time-lag produces an illusion of motion such as a horse jumping a gate. The stroboscope did the same trick, but like the parent toy was a rotating disc, hence more adaptable to the use of the magic lantern. However, there were also successful adaptations of the cylinder type of toy to lantern projection. In short, moving pictures already had a minor vogue in the sideshows of fairs and exhibitions for entertainment during the seventies and thereafter.

The physical principle of animation was now a commonplace and projection in a small way was a *fait accompli.* What was lacking was the means of keeping up the illusion long. The picture projected by the slides must needs be transparent. The only commercially available solid of high transparency was glass, and the rigidity of glass limits how many successive pictures it is possible to show to the number a disc or cylinder can carry. The only escape from this limitation, without recourse to an entirely new technique of projection, was the discovery of a substance having both the flexibility of paper and the transparency of glass. With such a medium it would be possible to reel off an endless succession of pictures.

The need for it was not in fact what prompted its discovery. A world shortage of ivory, through too efficient marksmanship of traders and natives newly equipped with rifles, loomed ahead of the billiard-ball industry. American manufacturers offered a ten-thousand-dollar reward for an ivory substitute. To them, Hyatt, a printer of Albany, sold his patent for making billiard balls out of a mixture of paper-flock, shellac and collodion. In the course of his experiments he got on to a new line, which he was now free to follow. By adding camphor to a mixture of ethyl alcohol and nitrocellulose, a substance first made by the Swiss chemist Schönbein, he obtained celluloid; and started to market it in 1869, in partnership with his brother. To be sure, he himself was not a chemist; but the discovery was possible, only because the laboratory had made nitrocellulose available.

The Hyatt brothers were not first in the field. The true parent of plastics was Alexander Parkes, an English pioneer of electro-metallurgy in a Birmingham firm, that of Elkington and Mason, and a prolific inventor whose eighty-odd patents include a rainproof coat subsequently called the *mackintosh* after the name of the company which became famous for its sale. In the early fifties Parkes made experiments on the use of collodion, an ether or alcohol solution of guncotton (nitrocellulose), as a carrier substance for photographic emulsions. He hit on the discovery of obtaining a hard product by admixture with cotton seed or castor oil and camphor; and in 1855 took out a British patent for *Parkesine*, a substance essentially the same as celluloid or xylonite. In the exhibition of 1862 it won several
 prizes; and its inventor delivered to the Royal Society of Arts in 1865 an

address claiming its suitability as a generic substitute for bone, ivory, horn, malachite, coral or tortoiseshell for manufacture of buttons, napkin rings, knife or brush handles, etc.; and a Parkes patent of 1879 specifically refers to billiard balls. How far the Hyatts knew of his success seems doubtful. It seems clear that Schönbein's agents encouraged inventors and industrialists to experiment on the uses of nitrocellulose, as it is likewise clear that the American market was more receptive to innovations than Victorian Britain, where the ingenuity of Birmingham inventors earned a poor reputation for the city as a threat to conspicuous expenditure and genteel ostentation.

Like glass in ancient times, celluloid did not immediately gain recognition for what is now its principal use. In thin sheets it has the disadvantage of being very inflammable; but in bulk, if suitably tinted, it offered possibilities for the manufacture of cheap *objets d'art* and jewellery, the more so in virtue of the ease with which it is possible to drill or to cut it. Photography was still in its childhood, when celluloid was seeking a market in this way; and we may credit Eastman of Kodak fame with an invention which anticipated the convenience of the camera film as a substitute for bulkier glass plates. In 1885 Eastman made a machine to coat long rolls of paper with a light-sensitive emulsion. Meanwhile he had begun experiments with a view to the improvement of celluloid, itself then too brittle to have its most obvious advantage over glass.

It was Eastman who first succeeded in making long rolls of highly flexible celluloid. In 1889 Edison obtained from him 50 feet of this new less brittle product with a view to the construction of a projector capable of carrying a continuous reel of pictures in place of a stroboscope disc attachment or its like. Within a month he was able to give a demonstration to prove that he had found the one missing link. To run off the reel, for the projector or camera alike, Edison and his assistant Dickson took advantage of a device within the domain of their main preoccupation. The telegraphic tape had perforated holes down the centre. To set the film in motion, it was needful only to put the perforations for the cogwheel of the driving mechanism of the projector at the edges. By 1895, the cinema was available for purchase by the highest bidder. In that year Edison's staff

111 *It was an economic convenience for the early cinema that suitable halls were being abandoned by the Edwardian roller-skaters. In 1907 the craze seems to have reached its zenith.*

produced the *cinématographe machine*, and in that year the first audience paid to see a moving picture produced by it.

In this context, Edison and his staff were not the only applicants for patents. In the same year Paul, an Englishman, made a commercially successful type of cinematic camera, and in 1896 patented a projector, the *Animatograph*, of his own design. By the turn of the century, cinematography was a thriving business; and if it did not pay big dividends at once, a reason is not far to seek. To establish itself as a new form of popular entertainment, it had to acquire buildings at an outlay of capital hard-bitten investors would contemplate with caution both because of its novelty and because of technical imperfections of its nonage. Americans, with less over-crowded cities than those of Europe and with a gold-rush tradition of improvising the erection of halls of entertainment, were most favourably situated to take advantage of improved technique of film production in the first decade of our own century. Elsewhere, the building problem was more formidable. What probably helped most in Britain, was the availability of cheap rinks after the rapid rise and fall of the Edwardian roller-skate craze.

If this were not a book about human communications, our account of the progress of photography might well take within its scope the panchromatic and the infra-red sensitive plate or film; but our preview of the possibilities of using the film to consummate the vision of Comenius would be incomplete if we omitted any reference to photographic reproduction in color. All forms of color photography, like the three-color printing process, derive their rationale from a circumstance inherent in Newton's discoveries concerning the spectrum. It is possible to build up any shade of color by combining in the right proportion the four pure colors, red, yellow, green and blue. The solution of the technical problem of color reproduction as we know it to-day dates from experiments (1861) of the great physicist Clerk-Maxwell, who used three magic lanterns to superimpose the same picture through different color screens. To take full advantage of Maxwell's extension of the Newtonian Scheme in the domain of photography, as well as of printing, was possible only when efficient *panchromatic* plates or films, in contradistinction to plates or films relatively insensitive to the red end of the spectrum, were on the market. This did not come about till 1906. Before that it was possible to get a balanced record of the effects of different parts of the spectrum only by unequal exposure through screens of different colors.

Most available accounts of the three-color printing process and of the rationale of color photography are somewhat confusing through failure to clarify essential facts about natural pigments and human vision. At the risk of wearying some readers (who may skip the next two paragraphs) the writer will therefore try to be more explicit than is usual in expositions of the problem of reproduction in color. To be clear about the technics of color we have to retrace our steps to Newton's time and to recognise two ways in which it is customary to use the word *primary* as applied to colors. Newton first showed how the prism resolves ordinary white light—daylight, oil-light, fat-light and wax-light in his time—into components like the notes of a chord of music. He was able to produce light which the eye does not distinguish from ordinary white light by using two prisms to superimpose from one and the same source its green and red components alone or its yellow and blue components alone. In fact, only two *complementary* colors are essential to the illusion of whiteness. It follows that the color of an object, as the eye registers it, may be due to either of two quite different circumstances. A pigment may transmit or reflect *only* the primary spectral color by which we recognise it; or it may transmit *all* colors *except* the primary color complementary to itself. For instance, ruby glass of the photographic studio lets through hardly any light except light at the red end of the spectrum, while our blood looks red merely because it blacks out a band in the green region.

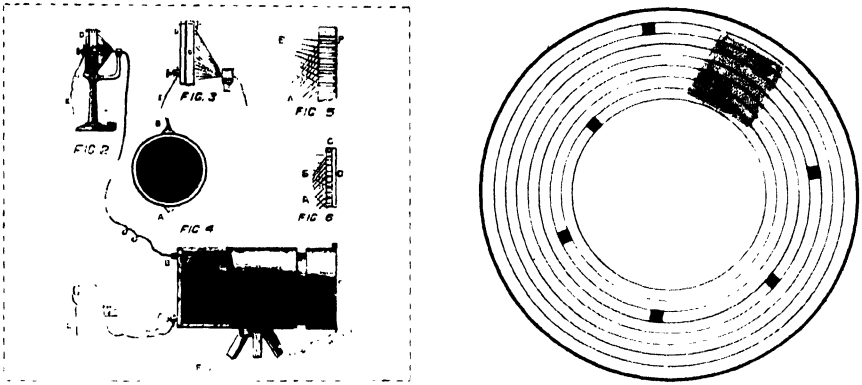
Let us now suppose that the magic lantern and the whole gamut of modern coal-tar dyes had been available in Newton's time, that it was then, in fact, possible to make color screens which would let through only primary spectral colors—or as we now say *monochromatic* light—of one sort or another. With four such color filters, it would thus have been possible for Newton to photograph the spectrum successively on panchromatic plates, and to obtain lantern-slide positives respectively transmitting white light only from the region admitted by the filter used, red if the filter were red, blue if blue and so on. By putting the same filter between the positive and the source of white light in the lantern he would then have been able to project on a screen an image in its appropriate color of the corresponding part of the spectrum as it appears to the eye; and there would be a complete black-out of the rest. By using four such lanterns focussed to superimpose their respective images, it would also have been possible to bring to life the spectrum in its entirety; and by the same procedure it would evidently be possible to reproduce in color a screen image of an object, as one sees it.

In principle, this was what Clerk-Maxwell did; but the practical difficulties were very great. As is easy to show, by passing through a prism light reflected from or transmitted by a painted surface, hardly any pigments are primary in the Newtonian—as opposed to the color photographer's—use of the term. In particular, pure blues are most difficult to come by. For natural blue pigments always reflect or transmit a good deal of green, whence the common trick of getting green by mixing blue with yellow, which is the complementary of true blue. Thus a range of pigments, primary in the Newtonian sense inasmuch as they black out every region of the spectrum other than the one which the eye registers as the region of the same color, was not available till the chemistry of the coal-tar industry had reached a very high level. Indeed, the writer himself was well ahead in his professional livelihood when the Ilford selection became available for his own experimental work on the color sense of the South African clawed toad. Maxwell himself had to work with what dyes were available before the coal-tar dye industry provided the laboratory investigator with a then undreamed-of range of choice; and the spectrograph was then in its infancy. In short, the three primary colors of the three-color printing process and of the handbooks on color photography are not at all primary in the sense in which we learn to use the term in our school or freshman courses of physics or physiology.

If you grasp the limitations within which Maxwell had to grope for a solution of the problem, you will therefore see that there was hard grind ahead for anyone who hoped to solve the problem of color reproduction in Maxwell's time. That he succeeded, shows how much tenacity imagination must call to its aid to produce fruitful results from experiment, and how little value we should set on child-guidance vocation tests if they fail to give us an over-all picture of human personality. That Maxwell's experiments did in fact bear fruit is partly attributable to the fact that they followed on the heels of an English discovery which German industry dramatically exploited. The revolution in dye production dates from Perkin's synthesis of *mauve* in 1857. Ten years later, the madder industry of France was on the verge of bankruptcy.

By 1869—in France—du Hauron had accomplished on paper color-photograph reproduction of a sort. That crude color production was not realisable as a commercial proposition till 1907 will not be surprising to the reader who appreciates what difficulties beset the inventor working within the limitations of the optical properties of available pigments and the sensitivity of available plates or films. Historically, commercial production proceeded in two stages, first the provision of a transparency, which is all that the film demands, then the production of a transcript suitable for reproduction on the printed page by the three-color process. The former derives its inspiration from Maxwell's experiments, the latter from those of du Hauron; but not until the thirties of our own century was it possible to reap advantage from the work of the latter. The beautiful reproductions of this book are a monument to a common feature of British and American culture. From Newton's time when craftsmen with the Italian glass technique settled in Britain, our community of technical resources has undergone perennial enrichment by the contribution of immigrant techniques. Britain is now the beneficiary of Hitler's expulsion of Austrians who have the best resources of color reproduction now available. Substantially, the only missing link in Maxwell's experiments *vis-à-vis* the newest techniques is that it is now possible to photograph one and the same image simultaneously on positive films impregnated with a dye corresponding to that of the color filter which transmits the rays from the camera lens.

A more novel technique of pictorial communication in our own time, and one whose educational possibilities are most difficult to assess, is television. If the story of it takes us down blind alleys, it takes us down them with the cheerfulness of the blind. In the seventies, the moon-element selenium, first detected from the lunar spectrum as an as yet unknown component of the earth's crust, was available for laboratory use; and a technician named May at an Irish cable station noticed that it offers less resistance to an electric current when exposed to light. Willoughby Smith, his supervisor, cashed in on the academic dividends of a discovery which his junior had already recognised as a means of transmitting visual images at a distance by electricity; but others were already on the trail. About the same time—or earlier—Carey of Boston designed the first outfit for visual transmission by the current. It was a blind alley; but we can understand the tenacious hopefulness which sustained later investigators, only if we paint into the background of the picture what positive basis for their confidence the work of unrewarded pioneers contributed to their success.



112 *It was the theoretical science of Clerk-Maxwell which pointed the way to man's latest triumph in human communication—television, but many pioneers struggled with its mechanical problems. The diagrams of Carey's apparatus (left) and Nipkow's disc show the mosaic of selenium cut-outs and explain how the holes of the scanning disc traverse the entire screen in a single rotation.*

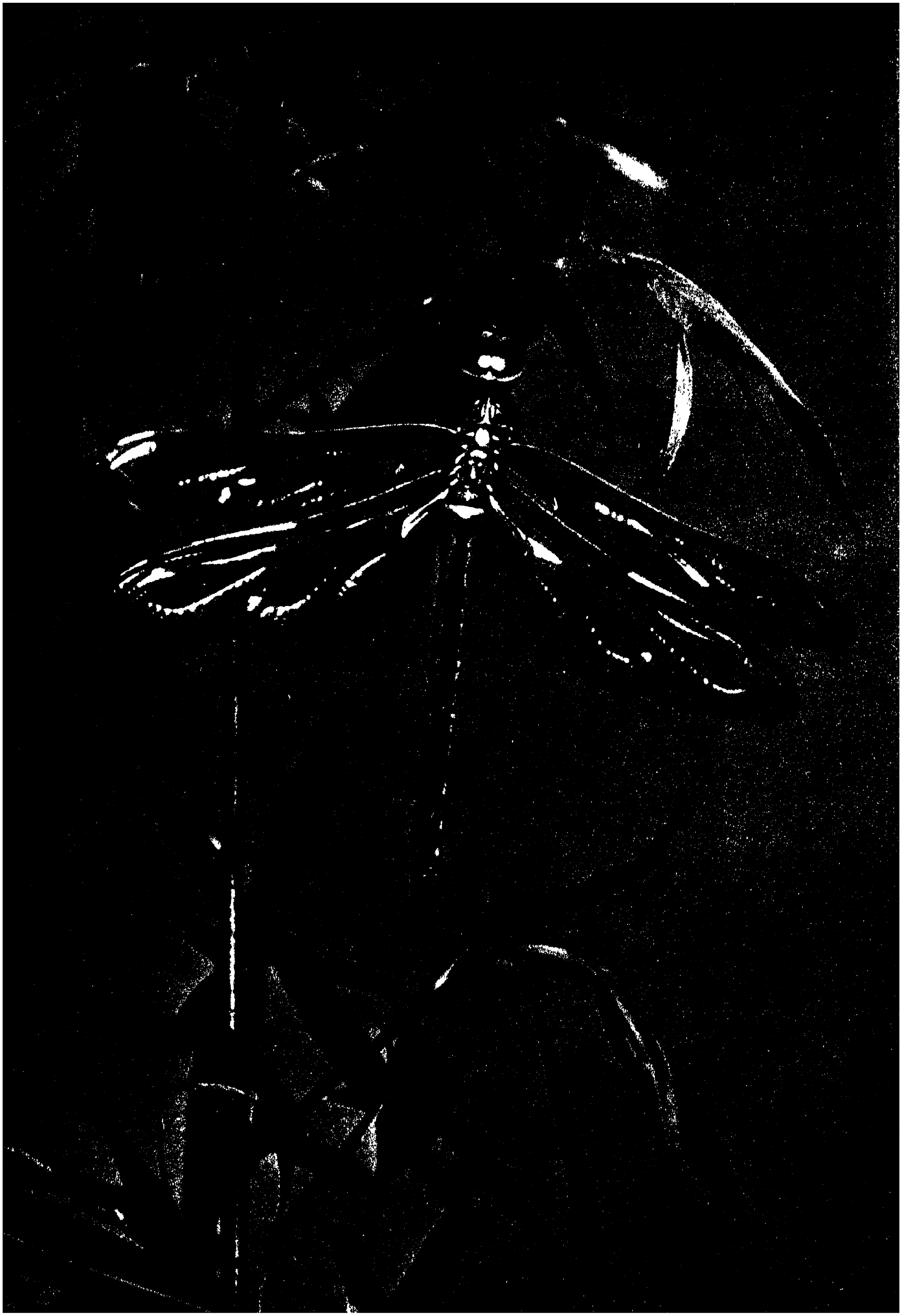
Carey's invention has a beautiful simplicity. It used the peculiar physical property of selenium as a cut-out mechanism. A cut-out is an arrangement which obstructs the flow of the current. If light makes selenium a better conductor, it is therefore possible to make light do what the hand does when we press the electric light switch. Such was Carey's principle. He made a mosaic of selenium cut-outs wired up with a corresponding mosaic of electric bulbs. Where there was light on the cut-out screen, the current came through, and light came on in the corresponding element of the frame of bulbs. The same idea occurred to others, in England to Ayrton and Perry, who described in *Nature* (1880) a similar system of *seeing by telegraphy.*

In real life, pioneers reap what little reward is their due only when they are more than ready for superannuation. By then they are a nuisance if, as rarely, they earn any reward at all. Carey and Ayrton earned nothing in the life that now is: but their work lit a beacon by dramatising the possibilities ahead of the exploitation of research in photo-electricity. The Carey project was impracticable for a sufficient reason. Pictorial transmission of electricity on the basis of the light-resistance effect could never conceivably have accomplished results on a canvas much smaller than Times Square sky-signs; and new discoveries of photo-electric phenomena were prerequisite to saleable television in the modern sense. None the less, and because of such men as Carey, television was in the air.

A pivotal discovery relevant to subsequent progress is the possibility of generating an electric current by the liberation of electrons from the surface of a metal through the action of light, as from potassium in an oxygen-free tube. This device is what we now call the photo-electric cell. No less important however is a device which depends on the time-lag of the human retina, as does the zootrope or the cinematograph. This takes us back to 1884. The inventor was Nipkow, who constructed a rotating disc with perforations arranged in a spiral, so spaced that a single hole at a time traverses a screen in front of a light source, and one or other hole traverses the entire screen in the course of a single rotation. When rotating, the disc lets through a spot of light from the source behind it just long enough to register a particular hole in the visual field as the site of an effective stimulus to perception. If it rotates at a suitable speed, the visual time-lag fuses the localised light stimuli in a seemingly contemporary illumination of the screen as a whole. Given a means of imposing an image on a second wheel rotating in synchronism with it, all we now need is a screen behind the latter to register light and shade of its projected counterpart fugitively dissected into its local elements by the layout of the perforations. The selenium cut-out is too slow for the job of getting the current into action; but the photo-electric cell jumps into action quickly enough. At the receiving end, a single light source concentrated on a single point in the retinal field by a perforation of the receiving disc now does the work of the countless bulbs which the Carey-Ayrton System requisitioned for the purpose. It must be a light which comes into action quickly enough: but here the principle of the neon tube comes to our aid.

All the ingredients for the concoction were available before 1900; but good cooks are made, not born. There was indeed little market for a

XV *Photography, little more than a century old, reaches its highest technical expression in the modern studies of detail in color. A wall of brick and chalk photographed by Percy Hennell with a camera using mirrors to split the colors into three negatives at one exposure.*



product with so novel possibilities until broadcasting brought electrical communication inside the home; and there was not yet a dominant ideology of the moving picture when the first attempts at television, which is essentially animated, were under way. A Russian physicist, called Rossing, patented a system based on Nipkow's disc in 1907. In essentials it is one in use to-day. Others put their ideas and experience into the common pool; but it was Baird who gave the first demonstration of moving images by television with sharpness of definition sufficient to hold out the prospect of worldly compensation. This was in London during January 1926. In 1928 he transmitted the first television picture from England to America.

First and foremost, television commands our attention in this context inasmuch as it is a highly economical method of distributing the animated picture. As such, it stands in much the same relation to the film as printing to the art of the scribe when writing was still a speciality. By the very speed with which it could produce copies of the written page, printing brought a new sense of unity to scattered communities with the same speech-habits, and by so doing participated in the midwifery of nascent nationalism. Contrariwise, television uses a language which transcends all barriers of natural speech. The world is its parish. It speaks with a new immediacy to men and women of all tongues, of every color and of all nationalities. It broadcasts from the Tower of Babel to the winds of heaven the tocsin of the unity of mankind. By the same token, it invites mankind to the immense economy of adopting by common consent a single world auxiliary in which it would be possible for every large printing-house to issue simultaneous editions by photographic reproduction from a single source. Hopefully and happily or reluctantly and resentfully, we are becoming world citizens, though as yet few of us realise the prospects of prosperity and of peril ahead.

XVI *Color photography to-day can capture the most transient beauty. This photograph of a newly emerged Emperor Dragonfly was taken by S. Beaufoy, using Kodachrome film and one flash bulb.*


CHINA

The Internationalisation of Free Speech

The great civilisations of Egypt, of Crete, of Mesopotamia, of Greece, of Rome and of the Moslem world have had their day and have met their doom. At a crossroad of history with a potential of self-destruction without precedent in the historic record, a culture common to Western Europe, to North America and to the British Commonwealth is under the impact of forces which have successively shattered its predecessors. One, the peril of war, scarcely calls for comment. The atomic bomb has made the unity of mankind under some sort of federal government a precondition to the further survival of a species which has now existed about fifty thousand years on earth. Henceforth, men can be bedfellows in a common grave, or co-partners in a common prosperity which the right use of science now makes possible.

There is another peril in one way more insidious, because we are less aware of it. With the havoc wrought by war to the cultural advancement of mankind we are mostly familiar. What all too few of us reflect upon is the nemesis of an avoidable folly against which the Cassandras of our own are as silent as those of former times. Their threadbare themes—luxury, self-indulgence, ostentation—point to symptoms of a decadence with deeper roots; and our narrative will have taught us little if it has failed to evoke a different attitude to the psychopathology of a culture on its deathbed. For we may well ask if any of the great civilisations of the past succumbed to external pressure until it had already forfeited the capacity for further growth, and that because its means of communication were inadequate to integrate community effort in the advancement of knowledge.

Such was the fate of the Alexandrian culture which embraced all the

113 *After 30,000 years of progress in human communication, mankind's efforts to co-operate for common prosperity are still thwarted by the Babel of tongues. Modern technology and skilled translators can help the nations to negotiate in council, but for the communications of culture and commerce the problem is still not solved.*

wisdom of the calendar priesthoods and the mercantile arts of Mediterranean commerce in the world of antiquity. The thought of Theon and of Diophantus ranged over themes which still excite the wonder of the mathematicians of our own generation; and all the essentials of sixteenth-century cosmogony or cartography are in the *Almagest* and the *Geographia*. None the less, the science of the ancient world was sick unto death when Ptolemy composed them. Long before the monks of St. Cyril dragged Hypatia from her forum to lacerate her naked corpse with oyster shells, the highest achievements of Alexandrian learning had become the prerogative of a privileged coterie out of touch with the common effort of contemporary mankind and powerless to enlist a sufficient personnel capable of carrying its burden. The culture of Theon and that of Diophantus went to its fate because no society is safe in the hands of so few clever people. No further advance was possible without a revolution in the common means of communication signalised by an innovation which came from the everyday experience of the common man. Such was the theme of Chapter IV, which we may recall in the words of Tobias Dantzig:

> This long period of nearly five thousand years saw the rise and fall of many a civilisation, each leaving behind it a heritage of literature, art, philosophy, and religion. But what was the net achievement in the field of reckoning, the earliest art practised by man? An inflexible numeration so crude as to make progress wellnigh impossible, and a calculating device so limited in scope that even elementary calculations called for the services of an expert. . . . Man used these devices for thousands of years without making a single worth-while improvement in the instrument, without contributing a single important idea to the system. . . . Even when compared with the slow growth of ideas during the dark ages, the history of reckoning presents a peculiar picture of desolate stagnation. When viewed in this light, the achievement of the unknown Hindu, who some time in the first centuries of our era discovered the principle of position, assumes the proportion of a world event.

Phases of rapid growth in knowledge occur when it is possible to mobilise a large and diverse personnel in the solution of new problems and of problems that have long defeated the ingenuity of others. New needs, new materials and new instruments contribute to a situation in which large-scale mobilisation of human talent is possible, but do not suffice to accomplish spectacular results if defective instruments for communicating discoveries defeat the free circulation of relevant information and economical co-ordination of new knowledge by comprehensive theoretical syntheses. When available means of communication limit the reciprocal participation of the theorist and those engaged in the everyday work of the world in day-to-day cross-fertilisation of theory and practice, a culture is approaching its climax. This is what is happening in the western world to-day. To say that the educational machinery of our time is utterly inadequate to take advantage of the tempo of advancing scientific discovery on any front is all too pitiably true of a generation so near in time to that of Joseph Priestley, to that of Faraday or to that of Edison; and the pity of it is the complacency we have in common with every preexisting culture in its decline. The voice of Robert Graves cries out in a wilderness of authoritarian specialities, when he declares:

> To know only one thing well is to have a barbaric mind: civilisation implies the graceful relation of all varieties of experience to a central humane system of thought. The present age is peculiarly barbaric: introduce, say, a Hebrew scholar to an ichthyologist or an authority on Danish place names and the pair of them would have no single topic in common but the weather or the war (if there happened to be a war in progress, which is usual in this barbaric age).

In the days of Faraday and Smithson, of T. H. Huxley and of Edison, it was customary to speak of science as organised common sense. It was the proud boast of Huxley that science was—and the past tense is intentional in this context—a bulwark against authoritarian thought of which the Churches were the last refuge. To say so now would be merely silly.

Travelling in opposite directions, physicists and liberal theologians, classical scholars and chemists, have long since passed one another. In 1875 men such as Huxley and Tyndall and Ball were giving with public demonstrations, as had Faraday before them, lectures to working men later printed as classics of lucid scientific exposition. By 1925 newspaper sensationalism scaled a pinnacle of inanity to publicise relativity before fifty per cent of university professors in departments of experimental physics had thoroughly examined its credentials or implications. By 1945, it would be safe to say that the pick of college students in the natural sciences had taken at least fifty per cent of knowledge necessary for examination success on trust.

In the higher levels of education and investigation, circumstances contributory to a disposition to take more and more on trust with less and less concern for rational grounds of confidence are evident on all sides. The constant pressure of foundations which finance research diverts the eager curiosity of the young investigator by speeding up publication of results in any field of enquiry with an aura of novelty. The policy of our institutions of higher learning penalises honest effort devoted to exposition of science to students or public alike by allocating academic promotion solely on the basis of mileage covered by repetitive reprints. In universities and in government research stations, heads of departments, ostensibly appointed by reason of capability to do original scientific work, soon discover that they are paid to be super-salesmen of problems nobody can solve when they might otherwise be occupied with problems for which they themselves could usefully find a solution. To say that the temper of science becomes daily more authoritarian is thus a truism for which we can blame neither Hitler nor Bolshevism. It is an inescapable penalty of *large-scale* scientific enquiry, if we fail to gear the tempo of educational technique to the tempo of team work in the laboratory.

From this viewpoint, the verdict of Robert Graves on our descent into barbarism is a masterly understatement, as the writer in his professional capacity, a medical statistician, may sufficiently illustrate by reference to his own speciality. In almost every teachers' training college of the Anglo-American speech-community success at the diploma examination hangs on the candidate's power to memorise certain assertions about human abilities and what particular types of psychological tests supposedly measure. The rationale of such propositions stands or falls with the validity of a statistical technique called factor analysis. Not five per cent of professors of psychology in colleges could give a sustained and lucid account of its credentials, concerning which the few expert mathematicians equipped to do so are not in fact agreed among themselves. It would also be safe to say that less than two per cent of biologists or sociologists have, or ever have had, any grip on the justification of statistical techniques universally employed in their specialities; and it is a commonplace that college courses in chemistry now introduce the freshman to atomic models vindicated by considerations to which he or she has no clue without two years' further study of physics.

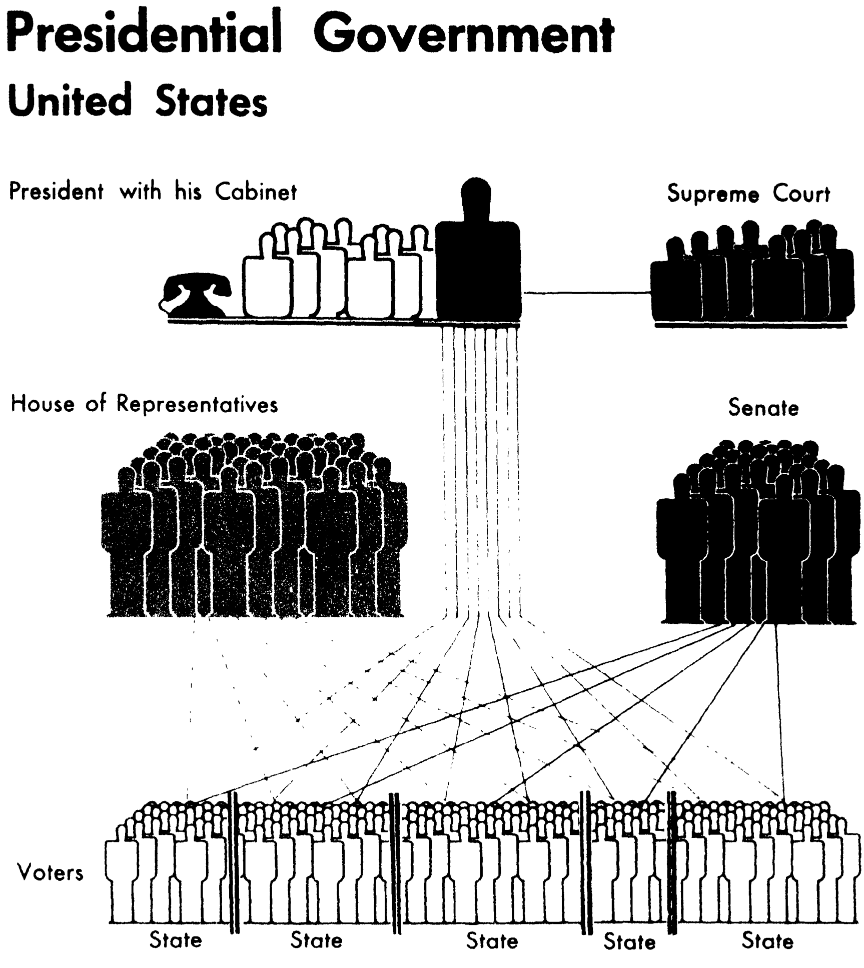
This new authoritarianism of the campus and of the laboratory would signify little, if we could turn for inspiration to the modern school where pedagogy has petered out in an orgy of pedophilia. Here the picture is more disturbing. A tradition of self-confident discipline, at least concerned to enforce a minimum standard of culture if often misdirected to promote book learning out of tune with modern requirements, has now made way for a saccharine preoccupation with self-expression inconsistent with the character of a culture steering its own course. Undoubtedly, it is true to say that you can prevent a boy from learning mathematics by means of the cane, as it is probably true to say that you can prevent him from talking in class by the same device; but the happiness of the child is not the goal of education in a society confident in its own future. At best, it is a technique more or less relevant to accomplishing one or other of the diverse aims of education with a serious end in view.

The aims of education concerned with the serious business of incorporating the child in an adult society are too diverse to fit into any simple formula of discipline free or fierce, including as they do equipment with a basic minimum of knowledge prerequisite to good citizenship and a basic minimum of knowledge prerequisite to intelligent specialisation, the inculcation of orderly habits of work and of a high regard for truth, the capacity to co-operate with one's fellows and to find satisfaction in pastimes which are not harmful to others. Modern educationists appear to agree about one thing only: that the linguistic and literary content of the curriculum of fifty years ago, often enforced with a ferocity which would be unnecessary to accomplish a programme more appropriate to the requirements of our own generation, is wholly inadequate to the needs of mankind on the doorstep of an era of atomic power. To say this gets us nowhere, if we have no more positive programme than to make the school years the happiest years of life, in other words to deprive the immature age-group of any incentive to further development or adequate preparation for the greater part of a life with a total mean expectation of about 64 years. Such morbid concern for the happiness of the child is merely a confession that modern education is all dressed up with nowhere to go.

We can arrest a process which ensures more and more people knowing less and less about what others are doing, only if we undertake an all-round and intensive speed-up of the educational process at all levels from the cradle to the grave; and our survey in this book of new instruments at our command should have shown us that the prospect is alarming only if we fail to read the writing on the wall. Indeed, the main items of such a programme should now be clear. It will help us to see them more clearly, and without undue despondency about the outcome of intelligent educational planning, if we first recognise where the machinery wastes most potential energy through avoidable friction.

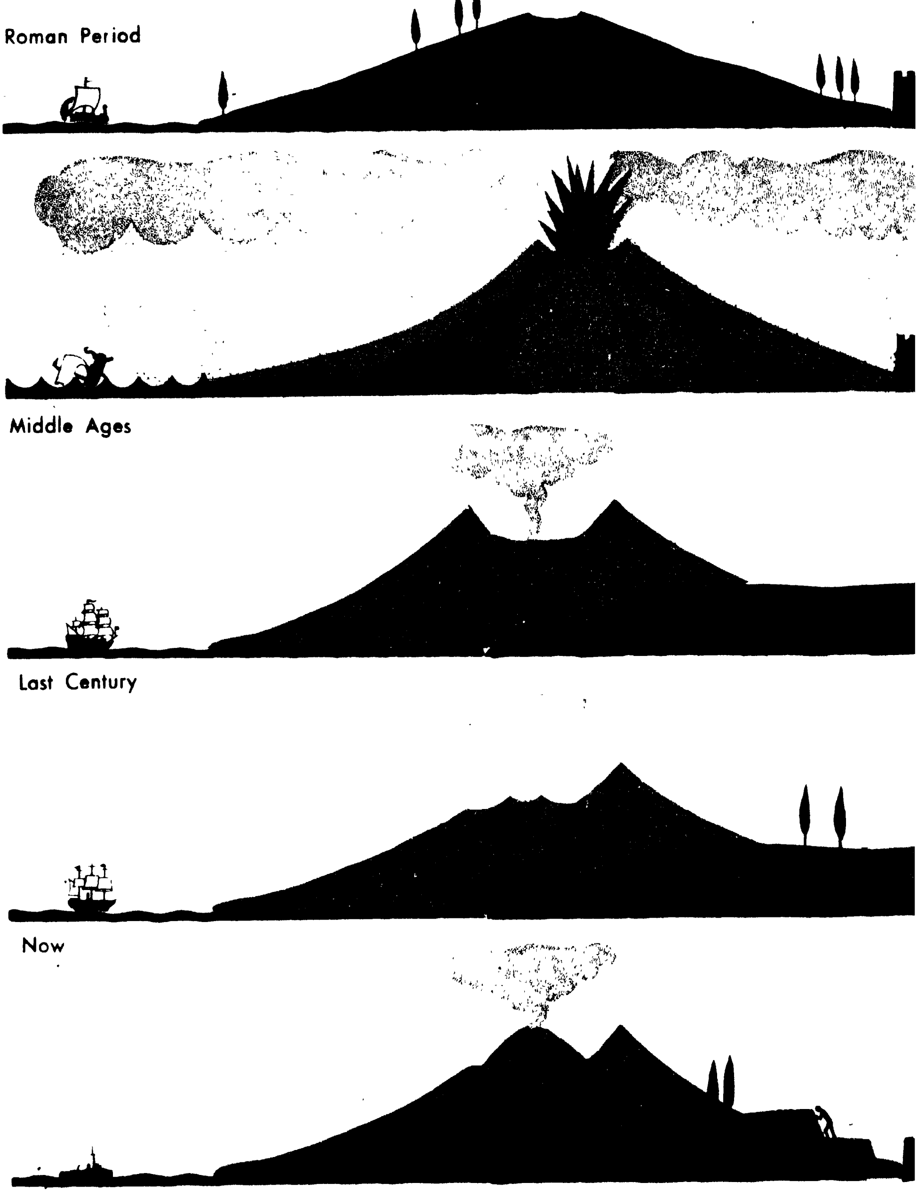
Let us first remind ourselves that formal education for the mass of mankind is an essentially modern phenomenon even in countries where literacy is universal. Throughout 95 per cent of recorded history instruction and discipleship were synonymous. The boy-child of the rich had the undivided attention of a tutor to satisfy his curiosity. The children of the artisan learned by doing things through apprenticeship, supplemented in more recent times, when a large segment of industry in Protestant countries was domestic, by what attention the mother could give them. When steam-power drove industry out of the home, and the wage system dictated a new need for literacy, a system of formal education came into being with a dual objective, to ensure that children could make use of the printed word and could perform the simple computations contingent on a pay-check economy. In this new setting of the class room, the insatiable curiosity of the normal child could take advantage neither of the undivided attention of an adult tutor nor of the stimulus which participation in the world's work confers. By the time the modern child has acquired a necessary familiarity with reading, writing and arithmetic, it has lost the habit of asking questions in an environment which deprives him or her of the opportunity to do so.

 In the seventeenth century, when class-room education was gaining

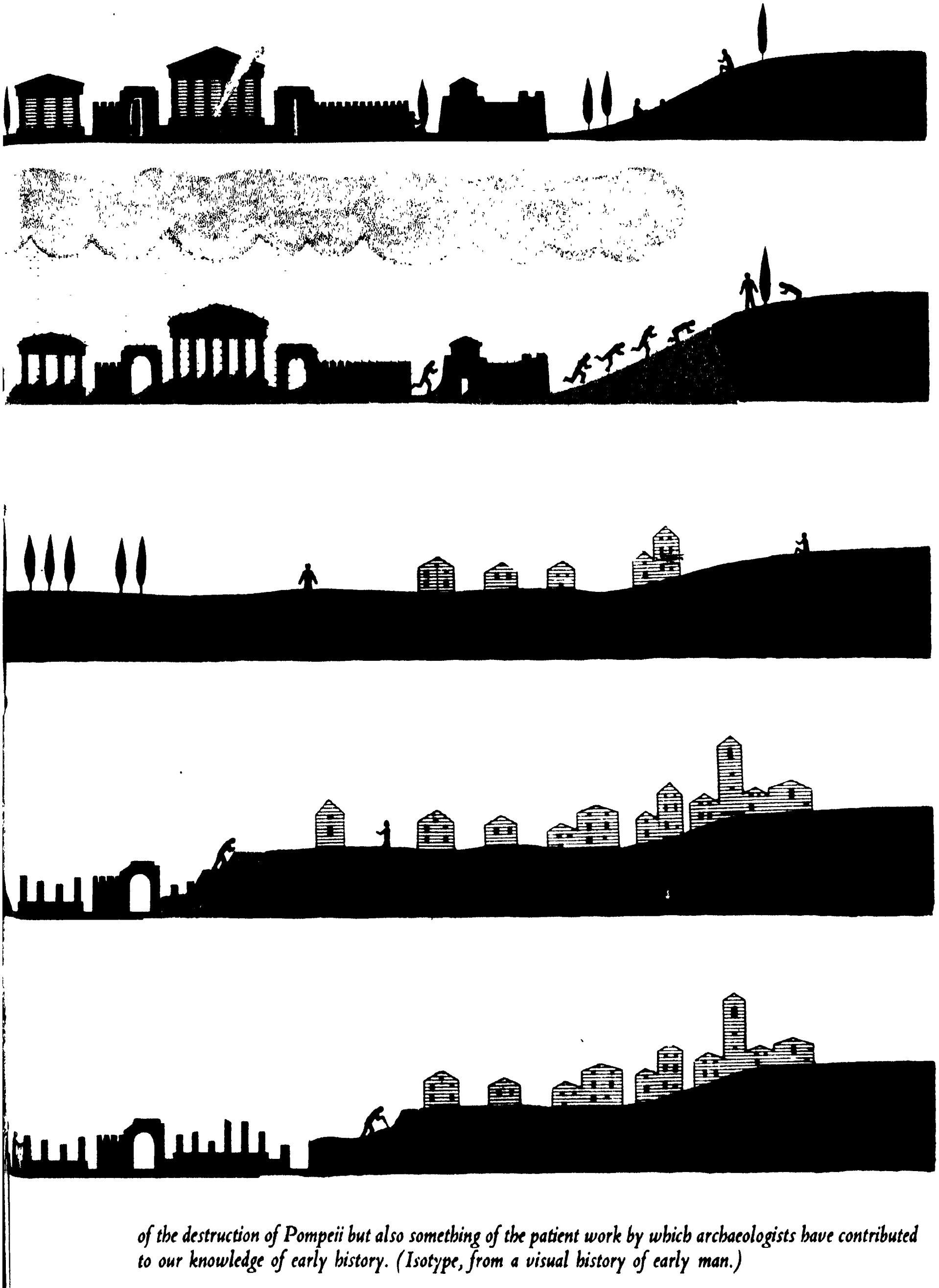


XVII *The dream of Comenius is entirely realisable in our own time. By taking full advantage of two centuries' progress in printing technique and in standardisation of printed symbols, Otto Neurath produced an educational tool at once more attractive and more efficient than the page of text. (Chart from "Our Two Democracies at Work" by K. B. Smellie.)*

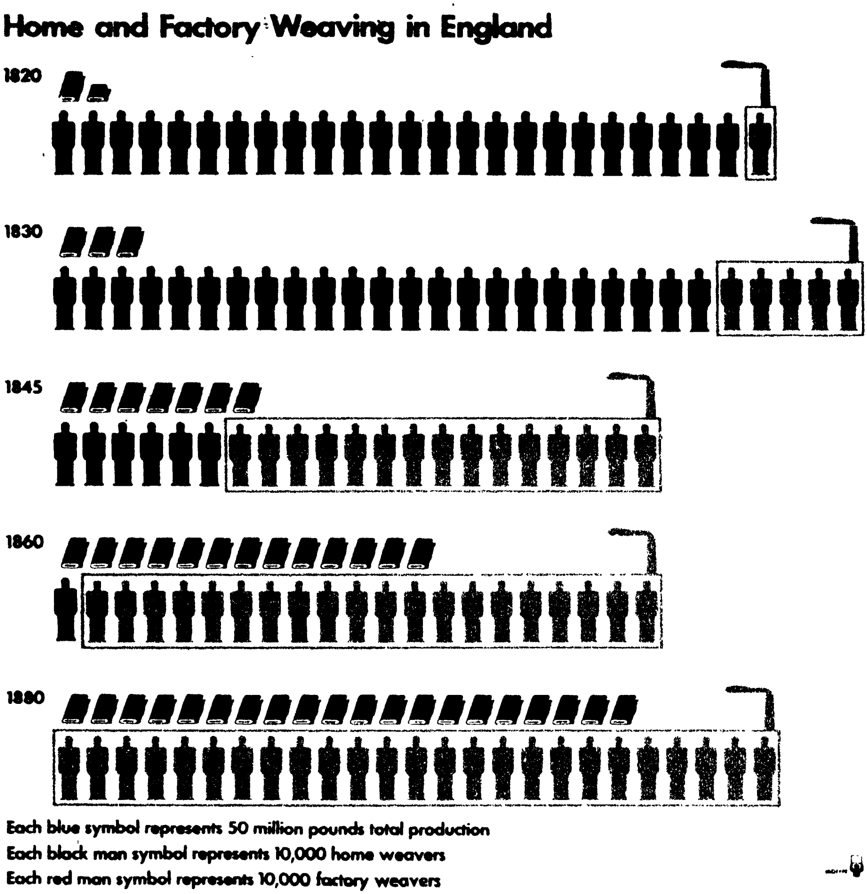
Digging down into History



XVIII *With the questions which accompany it, this chart exploits the interest of the quiz. After seeking the answers, which can all be discovered from the chart itself, the child grasps not only the story*



of the destruction of Pompeii but also something of the patient work by which archaeologists have contributed to our knowledge of early history. (Isotype, from a visual history of early man.)



XIX *Modern civilisation demands an intensive speed-up of the educational process at all levels. Social statistics presented visually, as in this Isotype chart from Otto Neurath's "Modern Man in the Making", are interesting and easily assimilated.*

ground, Comenius saw that this was unnecessary; and did not overstate the case, when he declared that "schools are slaughter houses of the mind where ten or more years are spent on learning what might be acquired in one . . . places where minds are fed on words". Why the good counsel of Comenius fell on deaf ears, we now know well enough, and well enough why the dream of Comenius is entirely realisable in our own time. Children crave avidly for humanistic information which books can supply long before they can take advantage of a free library; and we could immensely enrich the capacity of the normal child for further growth when able to do so, if we equipped the class room and the corridor with the means of maintaining a pictorial background to formal instruction necessarily focussed on the technique prerequisite to learning from books. By mass production and distribution of educational charts, exploiting to the full the puzzle *motif*, it is now possible to sustain the curiosity of the child under the continual impact of ever new sources of information about living in earlier times or about the modern world; and it is now possible to start doing so long before the child can read or write at all.

Such a programme for speeding up humanistic education for citizenship imposes the obligation to take the curiosity of childhood seriously; and this will be possible when we undertake the task with a wholesome regard for economy of symbolism, and face up to the difficulties of tempting an appetite fostered by daily commercialisation of the picturesquely novel. By the same means, we can do much to speed up the mathematical education of the child by familiarity with the natural—and social—history of numbers and of geometrical figures long before an age when we can reasonably expect the child to reproduce tediously trivial proofs for examination purposes in accordance with the prescribed ritual; but we shall do so without help from the comedians of the syndicated press.

In this matter, as in the full use of the Film as an instrument of enlightenment, we should not shirk the obligation to emancipate ourselves from a mental muddle perhaps less prevalent in America than in Britain, where it is still fashionable to proclaim the need for better teachers and for smaller classes. Education in a democracy signifies education on a scale so vast as to exclude the possibility of maintaining a high level of originality or talent in the teaching profession without withdrawing gifted personnel from necessary productive activity; and the call for small classes is merely an echo from an age when a few rich parents could employ private tutors. The brutal truth is that men or women with an outstanding gift for exposition are few, and of such few, very few would willingly embrace the boredom of continuous association with children. Good expositors are not necessarily good nursemaids or *vice versa*; and all the expository talent which a modern democracy can afford to enlist in the service of education should therefore be engaged in exploiting the new instruments of visual education at our command. In short, hopeful educational innovations are such as make good teachers and small classes less necessary.

The film technique can accomplish results which the wall chart cannot successfully undertake, because it can bring the passage of time within the range of immediate perception. This opens the possibility of a stupendous simplification of many branches of science—the physiology of the circulation and of the nervous reflex, electronics, dynamics and embryology. A powerful obstacle to the production of such films and to their most economic utilisation by television is the sensationalism inherent in commercial production and the ridiculous retinue of specialists whose pay-checks keep up the costs of a sound commercial proposition. So far, commercial production of educational films has undertaken no programme more ambitious than making the easily comprehensible somewhat more picturesque. Commercial film production—large or small-scale alike—has hitherto shown no prevision of the immeasurable possibilities for making what is now comprehensible to the few accessible to the many.

By films which make explicit the march of time in the abstract content of scientific hypothesis, by constant circulation of well-designed wall charts exhibiting the history of civilisation in color and quiz, the structure of the world we live in, the technic substratum of modern science, the elements of mathematics against its humanistic background, we can in stand the importance of cherishing this tradition; but we should not look at the current culture-conflict between the two great world powers in the same way if we had been born without a white skin in Southern Rhodesia, Nigeria or Malaya; and had there enjoyed what few educational amenities the local scene could offer. Our perspective would then be different, because a high level of general literacy is a precondition of a deep respect for intellectual freedom as we ourselves rightly conceive it.

The British do not yet sufficiently realise the world significance of the fact that Russia has prosecuted among the backward minorities taken over from the Czarist regime a programme to liquidate illiteracy with a vigour which makes the Soviet Union an emblem of hope to oppressed colonial peoples; and Americans, with a cleaner colonial record than the British, are utterly unable to grasp the military meaning of the fact that Paul Robeson can walk in the streets of Moscow, as he cannot walk in the streets of Washington, with a sense of human dignity. Thus, the U.S.S.R. can count on mobilising about a third of the world's inhabitants against the chromatocracies of the west, if we continue to indulge in the fantasy that America's technical resources for blasting a way to Atomic victory over the stricken and cindered corpse of Europe will curb Russia's appetite for expansion or fear of attack. It is an error of military judgment to conceive that Russia need be frightened of technical and manpower resources powerless to handle an Asia with a new assurance and an awakening Africa, if her armies are at the Channel ports with war industries in the Urals beyond the danger of attack from the air.

These platitudinous reflections may prompt the reader to ask: are we then to accept with resignation every new aggression and every new insult from the Soviet Union in its present mood of truculence? The answer is emphatically in the negative. Having realised that half-measures such as Western Union merely aggravate the common danger of mankind and seal the doom of European civilisation, our only life-insurance policy is to mobilise world opinion for a federal government which will respect the folk ways of *all* nations. Happily, there are Americans such as Robert Hutchins, as well as prominent men in British public life, who realise this; and happily some of them see, at least through a glass darkly, the pivotal but entirely surmountable difficulty of the task. Whether the U.S.S.R. would play the role of N. Carolina in the act of federation is a matter for not very profitable speculation. What is clear is the necessity for finding a formula of world federation which will sidestep controversy about representation in a world congress with due regard to two realities. One is that western nations will not lightly surrender national sovereignty on the basis of proportional representation while an overwhelming majority of the world's population is still illiterate. The other is that a franchise qualification based on literacy may well aggravate the suspicion that any such project is a super-imperialism to close the ranks for a coming clash with the Soviet Union still in a position of moral leadership *vis-à-vis* the colored peoples of the world.

Such a formula is not far to seek; and there would be already a firm foundation for immediate action if U.N.E.S.C.O. already had a policy as realistic as its sister food-control organisation. If the secretariat of Unesco had concentrated all its efforts to this end it would not have been a comic synonym for fiasco; and there would be the nucleus of what must be an essential instrument of world federal government. Since literacy admittedly sets a necessary limitation on representation in a system of government capable of salvaging civilisation, the acceptability of the principle assuredly demands action to forestall the suspicion that it is not a device to maintain the status quo. Hence a compelling proposal for world federal government must take within its scope the creation of a statutory body with powers:

(a) to enforce on trustee powers the obligation to implement a programme of universal literacy with a fixed time-limit in territories under their control;

(b) to make recommendations on the eligibility of backward communities to greater autonomy with due regard to educational progress;

(c) to revise at regular intervals the franchise qualification of independent nations not as yet eligible for representation on a basis of equality with western nations which have in fact established universal literacy within their own domains;

(d) to encourage international co-operation with a view to improving means of communication including weights and measures, the standardisation of scripts, and the adoption of a single *auxiliary* language for intercourse between members of different speech-communities;

(e) to facilitate the circulation of new instruments of education, especially the fullest exploitation of visual aids.

It is in this context that the exploitation of visual aids offers the greatest promise of immediate returns. With the best will in the world, missionaries who have hitherto done what little has been done for the education of the African continent labour under the handicap that native languages are poorly equipped with word-material for the transmission of modern knowledge and have no literature of their own. Higher education of teachers or of other specialists thus calls for familiarity with a language such as our own with a rich literature to draw on; and instruction with that end in view makes exacting demands on time, if wholly dependent on the written or spoken word. Wall charts and films produced with short *bilingual* captions are capable of creating an educational environment in which learning about the modern world and mastering another language proceed *pari passu* without difficulties attendant on assimilating a foreign idiom through the literary medium of an alien culture. A vigorous colonial policy with such instruments at its disposal could indeed accomplish in two decades far more than voluntary missionary work could encompass in a century. Nor would the African be the sole beneficiary. The awakening of Africa and Asia will be the signal for a world-wide recognition of handicaps which beset ourselves.

We have already had occasion to remark that technical journals recording modern scientific discoveries are now appearing in at least a dozen languages. If this goes on, the Babel of tongues will make further international co-operation in scientific work impossible. As matters now stand, any educated European has to get a reading knowledge of at least two languages other than his own; and language teaching in America, where there is no incentive from day-to-day contact with alien speech-communities, is the despair of the educationist. The fact is that few teachers who read Dostoievsky, *Burnt Njal*, Ibsen, Strindberg or Omar Khayyám from translations can mobilise the effrontery to pretend to their pupils that there is much dividend in learning languages as a passport to the world's literature.

While it is a fact that instruction in a second language is obligatory for high-school education throughout the civilised world, and in many countries is part of the curriculum at a lower level for all children, the number of such second languages is legion; and we could relieve education of a considerable encumbrance by international agreement of all nations to use one and the same second language as a world *auxiliary*. Such a *second* language should be one in which children can progress towards proficiency more rapidly than is usual. This is a sufficient objection to the choice of almost any natural language except some form of simplified Anglo-American, such as Basic English; but there is one powerful obstacle to the adoption of any such simple solution. The choice of any *natural* language would give those who habitually speak it an unfair cultural advantage. Thus, a wholly satisfactory auxiliary must be everybody's language because it is also nobody's language.

International exploitation of visual aids points the way to a considerable simplification of the task of learning a suitable auxiliary, if we recognise the force of this contention. A constructed language teachable by use of visual aids alone would entail a minimum of book production costs, since any primer would be suitable for issue simultaneously in a one-world edition; and no language is teachable by recourse to visual aids alone unless it *relinquishes all grammatical apparatus except word-order,* as does Chinese and—it is almost true to say—Ogden's Basic. Having off-loaded the dead weight of grammar from the curriculum, the next task ties up with the possibility of producing visual aids overstepping language barriers for scientific instruction.

The difficulty of learning a foreign language depends partly on whether we can easily form associations to its word-material, as we do when we associate the French *aimer* with *amiable.* Modern technology offers a painless solution for this problem, because science has already created a world-wide vocabulary of its own. As western technology transforms everyday life, what was once the jargon of the laboratory becomes the vocabulary of the street. Pyrex and pyrotechnics, aeroplane, aertex, aerodynamics and aerial, hydrant, hydrogen and dehydrated potatoes, geography, geodesy, geometry and geopolitik provide the bricks of what are the only possible auxiliary words for fire, air, water and earth. As the writer has elsewhere pointed out, all the bricks of a minimum vocabulary of world-wide communication are in fact available in the world-wide language of science; and it would now be possible to make every lesson in elementary science a lesson in a constructed auxiliary which the pupil would absorb without additional effort.

There are indeed no grounds for hopelessness about the fate of our culture, if we face the future with courage to try new expedients, with modesty to acknowledge how we are handicapped by lop-sided specialisation, with self-assurance to tackle the serious tasks of education unhampered by sentimental preoccupations and with generosity to share with others a social heritage to which peoples of other continents and of other color have contributed so much. If we do so, later generations may recall our own as the beginning of a golden age. If we fail to do so, there may be no men or women left to record our failure.

INDEX

Figures in italics refer to pages on which illustrations fall. In the case of color plates the references are to facing pages

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