DOES SCIENCE TRANSCEND CULTURE?

by

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Submitted in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy
in the
Faculty Of Education
University of Ottawa
1958

ABSTRACT

of thesis presented by

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This is a study of whether Science DOES transcend Culture *naturally* – not whether it CAN do so.

That Science can be adopted into any culture is clear from modern history (as in China today). That Science doe not *automatically* develop even when a Culture has reached a high level of technical achievement (as in modern China) or intellectual sophistication (as in ancient Greece) is also clear from history. Evidently Science and Technology are not the same thing, for none of these high Cultures ever succeeded in crossing the threshold into an Industrial Revolution. Yet it did appear in Europe where Technology is not particularly remarkable, but Philosophy is.

Research has shown that non-Indo-Europeans are highly inventive and responsible for all basic Technology, but are quite un-philosophical. On the other hand, Indo-Europeans are quite uninventive but philosophically inclined and responsible for all philosophical systems. Neither Philosophy nor Technology *alone* is capable of producing Science. Only when Philosophy is applied to Technology does Science arise.

An examination of the reasons for these circumstances constitutes the subject of this thesis. To the question, *Can* Science transcend Culture, the answer would be unquestionably, Yes. To the question, *Does* Science transcend Culture, the answer apparently is NO. Science *can* transcend Culture but apparently it does not by *nature* do so. It thus appears to be an activity that is culturally conditioned.

The interrelationship between language and thought is explored: evidence show that non-Indo-European languages do not permit or encourage speculation of a philosophical nature, whereas Indo-European languages do. How did this bifurcation come about and what factors tend to preserve it? Did language predetermine thought patterns, or has some mental characteristic, possibly genetically determined, been responsible for the structure of language?

The possible relevance of all this in terms of educational methods is considered. By formulating precisely the relationships between Philosophy, Technology, and Science, and by giving attention to the part which the structure of Language plays in these relationships, it is hoped to give some direction to the content of Education needed to train and equip Scientists.

Science is distinctly a cultural pattern, and the methods and techniques of Science are elements of that cultural pattern.
John H. Rohrer

American Journal of Psychiatry
Vol. 109, March 1953, 678.

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INTRODUCTION

The Title of this Thesis is carefully chosen. It is a study of whether Science DOES naturally transcend Culture– not a study of whether it CAN do so.

That Science can be transplanted into, and adopted by, any Culture which did not previously have it, is clear from history. But it is not at all certain that Science is a natural outgrowth of a certain level of technical competence in the sense that once that level has been reached, Science automatically develops to extend it. If this were the case, it should have arisen several times in the past in certain non-Indo-European Cultures – where, in fact, it did not arise. Four or five such Cultures have reached a very high level of technical sophistication and intellectual achievement but for reasons, which will be examined carefully, Science did not develop. Evidently Science and Technology are not the same thing, though they are related. The former is rare; the latter is found in every Culture from the most primitive to the most complex.

On the other hand Science CAN transcend Culture. In comparatively recent times China has adopted the Scientific Method and is now applying it in the solution of many basic problems. It does not appear, however, that she would have developed it on her own, in spite of the genius of her engineers and craftsmen in the past centuries. Having reached a certain level, Chinese civilization remained static for a long time, and then gradually decayed so that her Golden Age passed away and her Culture settled down at a somewhat lower level. There it remained for centuries.The phenomenal change which may come to a Culture with the introduction of Science is beautifully illustrated in a

recent report by James Muir, Chairman and President of the Royal Bank of Canada, who visited China during the summer of 1958. In one place he describes his reactions as follows:[1]

> The growth of industry, the change in living standards, the modernization of everything and anything, the feats of human effort and the colossal impact of human labour are not within our power to describe and still give a worthwhile picture of the scene. All I can say is that it must be seen to be believed. It is truly stupendous.
>
> The effect is almost to bewilder one when he sees what has been accomplished in less than 10 years but, if he is a thinking person, to appal him and dumbfound him when he realizes what had not been done in the previous 4000 years or even 100 years.

What is true of China has been true of all high civilisations which were not of Indo-European origin. None of them succeeded in crossing the threshold into an Industrial Revolution such as resulted from the introduction and development of the Scientific Method in Europe. It is therefore a remarkable fact that although a number of such high Cultures have arisen, Science – as a method of vastly extending control over the forces of Nature – did not appear in any of them: yet it did appear in Europe where Technology was not particularly remarkable.

Cultures seem to enjoy a certain 'specificity' and some types of human activity apparently do not develop automatically unless the Culture happens to be of the right kind. Such activities may be introduced by outside pressure, or by influential newcomers, or as result of a kind of cross-fertilization in times of emergency. But they are not natural outgrowths.By borrowing an illustration from biology, we may point up the difference between the word DOES and CAN, in this context. Adolph Schultz has stated that:[2]

> All the distinct forms within an anthropoid genus *can* readily hybridize [as] has been proved for Gibbon, Orangutan, and Chimpanzee [emphasis his].

But although these animals can be persuaded to interbreed they do not do so naturally. Their characteristics are sufficiently marked that each species does not, by nature, transcend its appointed niche in the economy of things. They only transcend these boundaries under considerable pressure applied from outside.

Cultures, like species, also tend to preserve their integrity, encouraging certain activities but not others, and by no means following the same pattern of development in each case.

To give a reverse illustration: while no non-Indo-European Culture has ever initiated the development of Science, Indo-European Cultures have apparently never favoured Totemism,[3] though it is common enough elsewhere and seems to have arisen quite spontaneously in widely separated areas evidently in response to a social need. Totemism arises because of a certain feeling which a Society has towards Nature. This feeling is evidently largely lacking among Indo-Europeans. The lack is related, as will be shown, to the same attitude of mind which opened the way for the development of Science.

It seems, therefore, that Cultures have a certain 'individualism' which is preserved intact so long as the situation which permitted their growth and development is not seriously challenged. The stability is in fact a social necessity in many cases, and rapid cultural change usually generates sufficient tension and anxiety in the community to lead

to the rejection of innovations – especially in certain circumstances which will be discussed subsequently.

But it does not arise within any species of Culture merely because a certain level of Technology has been achieved.

In one area which witnessed the rise and development of Science, it can be shown that there was little inventiveness or ingenuity displayed by the Culture – in marked contrast to those areas in which it did *not* arise, where inventiveness and ingenuity are strongly in evidence.

A number of authoritative works have been published in recent years dealing with the Technology of both Indo-European and non-Indo-European Cultures, and these speak freely of the 'Science' that such Cultures have developed. However, it is all too easy to confuse Science and Technology, in the same way that it is easy to confuse Philosophy and purely practical wisdom. Both these confusions of thought are related, I think, and both seriously hamper our understanding of historical processes.

Dr. George Sarton makes the following observation in this connection:[4]

> The great intellectual division of mankind is not along geographical or racial lines, but between those who understand and practice the experimental method and those who do not understand and do not practice it.

Yet in his book, *A History of Science*,[5] the same writer seems to confuse the technical achievements of the Middle East Cultures of antiquity with Science! He credits the Sumerians and Babylonians and the Egyptians with Science of a kind, where we might feel

that the ascription is not due, since the achievements were purely practical and should therefore rather be called Technology. As James Conant has put it:[6]

> The distinction between improvements in the practical arts and advances in the Sciences would be one of the recurring topics in a course on the Tactics and Strategy of Science. The difference between *invention* and *Scientific discovery* may in a few instances seem slight but a confusion between the history of the practical arts and the development of Science is a fruitful source of misunderstanding about Science ...
>
> There can be no doubt that knowledge has been accumulated, classified, and *directed to some practical ends* ever since the dawn of civilization. Yet very little is to be learned about the Tactics and Strategy of Science by studying the history of these advances. *For they do not form a part of Science.* [My emphasis throughout]

I think they *do* form a part of Science, and this Conant would be the first to admit. What he means rather is that Technology is not the 'father' of Science – its source of inspiration does not lie here, through a direct generative process. Yet, a relation exists.

That these Cultures and others in the New World and the Far East developed a remarkably high degree of skill and knowledge is not questionable: that they developed any Science at all is not so certain. And there were many among them with great practical wisdom: but it is not at all clear that they were the least bit concerned with Philosophy as we understand it. Ptah-hotep in Egypt, Confucius in China, Pachacuti in Peru these men were very wise, in a canny way. But they were not Philosophers. In ancient India the situation is more complex.

An examination of the reasons for this circumstance constitutes the subject of this Thesis. To the question, Can Science transcend Culture, the answer would be unquestionably, Yes. To the question, Does Science transcend Culture, the answer is

apparently, No. Science can *transcend* Culture because it may be transmitted from one Culture to another – although this transmission usually brings some modifications to the Grammar of the language of the recipient. It apparently does not *by nature* transcend Culture, however, because only one particular type of Culture ever witnessed its initiation. It thus appears to be an activity that is culturally conditioned in some way. Not until Philosophy was applied to Technology did Science develop. Where there were no philosophers, there was no Science, no matter how well developed the Technology was. But conversely, without this 'pabulum' of Technology, Philosophy has not given birth to Science even where genuine Philosophers were to be found.

My proposal is to show in Chapter one that non-Indo-Europeans have been highly inventive and ingenious, and that there is scarcely any single basic element of Western Technology in which they did not anticipate us, and which in fact we did not borrow from them. There are cases where the necessary links to demonstrate this borrowing are lacking, but in such cases the non-Indo-European has at least anticipated us and often by many centuries.

In the second Chapter, an attempt is made to demonstrate two negatives. This is always difficult. Research seems to show that while non-Indo-Europeans have been so inventive, they have never produced Philosophers. And conversely, while Indo-Europeans have not been particularly inventive, they have a genius for philosophical speculation.

In the third Chapter, the interrelationships between language and thought are explored and some evidence is presented which shows, I think, that the

non-Indo-European languages do not permit or encourage speculation of a philosophical nature, whereas the Indo-European languages do.

In Chapter four, a number of relevant issues in this study are considered, and some general conclusions drawn. These issues include among others some thoughts on the basic question as to how the ultimate bifurcation of mankind along these lines came about historically, and what factors tended to preserve it. Did the language predetermine the thought pattern, or has some mental characteristic, possibly genetically determined, been responsible for the language structure? The findings of research in prefrontal lobotomy seem to throw some light on this point. The possible relevance of all this, in a practical and applied way from the point of view of modern educational methods and goals, is given consideration.

Some clear definitions of the basic terms as used by the author are essential and an attempt is made to satisfy this requirement on the two following pages.

SOME PROVISIONAL DEFINITIONS

	TECHNOLOGY	SCIENCE	PHILOSOPHY	RELIGION
	Knows how..... invents.....	Asks why Discovers	Strictly rational speculation	I - Thou
Seeks:				**Magic**
	Control..... by Search.....	Understanding by Research	*	me - it
			Concerning the ultimate nature and meaning of reality.	**Science**
Answers are:				me - it
	Specific..... Practical..... Temporary.....	Universal Theoretical Enduring	*	
Advantages are:			Apart from revelation	
	Deliberate..... Foreseen.....	Incidental Accidental By-products	*	
Creates:			To satisfy purely intellectual needs	
	Devices..... Practices.....	Hypotheses Principles		

Science is concerned with Physics and need only the help of technology for its instruments. Its problems change.

Philosophy is concerned with Meta-physics and requires only a healthy mind. Its problems remain unchanged.

Note:
The above is intented to indicate that the religious attitude looks upon the object of worship as superior, hence the capitalized pronoun 'Thou'.

Magic looks upon Nature more as an equal, but still as a 'person'.

Science looks on nature as impersonal, and man superior.

The above is an attempt to summarize and contrast some of the essential distinctions between Technology, Science, Magic, Philosophy, and Religion. Other definitions are given on the next page.

	CULTURE	CIVILIZATION
	The spirit of a civilization	The mechanics of a Culture.
Emphasis on:	Man's control of his social environment.	Man's control of his physical environment.
Progress lies in:	fuller realization of the potentialities of the individual for himself and society	increasing conversion of luxuries into necessities The individual important only for his functions, not for himself.
Defined as:	Learned behaviour patterns and solutions shared by a community as a system of values.	Learned behaviour in the form of skills and techniques, to deal with things.

PRIMITIVE PEOPLE: An unfortunate term which will in time perhaps be replaced by the more appropriate term "pre-literates" which is really the most comprehensive definition of what is meant.

INDO-EUROPEANS: A very inexact term which is most meaningful when viewed from the point of view of Language Families. In India it refers to those who could be traced back to the Aryan element in the population, if such an undertaking were historically possible. In Europe, it means essentially all those who have shared in Western Traditions, excluding only a very small group such as the Basques, who are racially distinct. As a language designation it is composed of the Romance group (the French, Spanish, Italian, Portuguese), the Teutonic (German, Dutch, English, Danish, Swedish, Icelandic, Norwegian, Flemish and the now extinct Gothic and Norse), the Latin, Greek, Sanskrit, Hindi, Armenian, Lithuanian, the Celtic group (Erse, Gaelic, Breton, and Welsh), and the Slavonic group (Polish, Russian, Czech, Serbo-Croat). All are considered as descended from a common tongue once spoken somewhere in Central Asia.

A Note on the Source Materials

The source materials for this Thesis extend over a very wide range of literature, and in a very small number of cases these might not be considered the best. The fact is that few authors have been altogether aware of the total picture which seems to emerge from this Study. Consequently one frequently finds a single item of value that clearly contributes to the overall picture, in a text which for one reason or another might not always be considered suitable.

Much of the data is derived from Technical and Scientific journals and periodicals in the fields of Architecture, Anthropology, Physics, Mathematics, Human Genetics, Science in general, Metallurgy, Linguistics, and Science History. Some of it is derived from philosophical treatments of these subjects. The majority of the references to Technical literature or periodicals, are completely up to date.

In certain areas, notably Aegean Prehistory, and Primitive and Early Metallurgy, as well as the Archaeology and Ancient History of the Middle East, extended studies were first made, preparatory to this Thesis. In these areas in particular, some of the background of certain generalized statements is omitted from the text in the interests of brevity.

In some cases it may be wondered *why* any documentation was necessary at all for observations which are commonplace. However, in all such cases the sources of reference have been given because:

(1) the original article contains further relevant data which the reader may find of interest (e.g., the origin of Coffee),

(2) the original author has employed a number of apt phrases which the present writer did not wish to appropriate without acknowledgement (e.g., Clive Bell on the Athenian view of 'the good life', or 'exceptional native personalities'),

(3) the reader may wish to see the context in which such a statement is made (e.g., 'spray painting' in Palaeolithic times).

In few instances, a secondary source is used because it was the only source in which the writer had the opportunity to recheck the reference (e.g., Chinese 'spectacles'). In such cases the original source is also indicated.

Dates given in the details of publication are the dates of the last copyright, or revision, or reprint in a new form, and not necessarily the actual dates of when the volumes were written.

A great deal of 'inspiration' has been derived from books from which no actual quotations are used and which therefore do not appear in the Index. The Select Annotated Bibliography contains some volumes which have contributed in this way, without actual reference in the text of the Thesis.

There are of course innumerable other unacknowledged sources from which various aspects of the Thesis were derived, consciously or otherwise. As far as possible any claim or implication of originality where it does not exist has been avoided.

CHAPTER I.

THE INVENTIVENESS OF NON-INDO-EUROPEANS

It is customary to view Western Man as the most inventive creature who ever lived, and other peoples as unimaginative and backward by comparison. For this reason it has never surprised those who write textbooks of History that our own civilization advanced so far ahead of all that preceded it.

Obviously we are more inventive and so we have naturally achieved a higher civilization. At one point in time, the stage was set for the logical development of Science and the proper extension of a certain innate superiority in controlling the forces of Nature for our own benefit. Science thus developed automatically. Very few people, until quite recently, were aware of the achievements of other ancient, and modern, Cultures which have not shared our tradition. Their arts and architecture were remarkable enough; but their mechanics and Technology were of little account except for an occasional odd device like the compass, etc. And our own uninventiveness as a whole completely escaped notice. When it was found that Eskimos could be trained to operate *and repair* sewing machines and watches as quickly as (if not more quickly than) we ourselves, some surprise was expressed.

In time the ingenuity of the Eskimo became increasingly apparent, and writers began to vie with one another in their search for superlatives to describe these otherwise 'backward' people. But it soon became evident that the Eskimos were not alone in this. Their wilderness of ice and snow and their inhospitable environment is shared in a

different way by other primitive people, whom it now turns out have proved themselves to be quite as ingenious in making the most of the immediately available resources of this environment. For example, there are the Indians of the Sonoran Desert in Southern Arizona. Considering their environment, it is quite amazing to find what they have succeeded in extracting out of it. Throughout this discussion of primitive Culture, and in much of the treatment of more highly complex civilizations of non-Western tradition, it is necessary to bear in mind that the greatest displays of ingenuity frequently appear in the exploitation of the *immediate* resources of the environment rather than the secondary or less immediate resources.This recognition, given somewhat belatedly, is now being accorded at high levels. Claude Lévi-Strauss, speaking officially for UNESCO, made the following admission in attempting to establish who has made the greatest contribution to the world's wealth:[1]

> If the criterion chosen had been the degree of ability to overcome even the most inhospitable geographical conditions there can be scarcely any doubt that the Eskimo on the one hand and the Bedouin on the other, would carry off the palm.

He might equally well have used the Indians of the Sonoran Desert in place of the Bedouin. And one could have included another rather rugged environment, the high altitudes of the Peruvian Andes, where the Aymara have shown themselves well able to hold their own with the Eskimo, the Bedouin, and the Indians of Arizona. Let us examine very briefly some of the achievements of such people.

Primitive Cultures: Past & Present

One of the best modern authorities on this aspect of Eskimo life is Erwin H. Ackernecht. He writes:[2]

> The Eskimo is one of the great triumphs of our species. He has succeeded in adapting himself to an environment which offers to man but the poorest chances of survival ...
>
> His technical solution of problems of the Arctic are so excellent that white settlers would have perished had they not adopted many elements of Eskimo technology.

Frederick R. Wulsin, an authority on clothing problems for cold climates, says candidly that "There seems to be no doubt that Eskimo clothing is the most efficient yet devised for extremely cold weather."[3]

Of this we have had personal experience, and can affirm its truth without hesitation. Moreover, to the Eskimo must probably go the credit for developing the first 'tailored clothing' and, not unnaturally, the first thimbles.[4]

In addressing a Scientific Defence Research Symposium in Ottawa, in 1955, Dr. O. Solandt admitted frankly that:

> The White Man has not introduced a single item of environmental protection in the Arctic which was not already being used by the natives, and his substitute products are not yet as effective as the native ones. Only in his means of production has he the edge.

Ackernecht continues subsequently:[5]

> A very short review of the Eskimo's hunting techniques has already revealed an extraordinary number of well conceived implements. Eskimos are described as very "gadget minded" and are able to use and repair machinery such as motors and sewing machines with almost no instruction. It is impossible to give here a complete list of aboriginal Eskimo instruments the number of which and quality of which have been emphasized by all observers ...

> The best known type of Eskimo house is undoubtedly the dome shaped snow-house with its ice window. With extraordinary ingenuity, the very products of the cold are used here as a protection against it.

It might be thought that once the idea was conceived, the construction or such a house would be comparatively simple. Actually it is remarkably difficult to construct a dome, without any means of supporting the arch while in the process of completing it. As the wall rises, it converges upon itself. Each new block overhangs more and more until near the top they rest almost in a horizontal plane. The problem is to hold each block in place until the next one ties it in, and then to hold that one until it too is tied in place.

Given enough hands the problem is not so difficult, but the Eskimos have overcome the problem so effectively that a single individual can, if he has to, erect his own igloo single-handed without too much difficulty.

The solution is to carry the rising layers of blocks in a spiral instead of in a series of horizontal levels. This is shown in Fig. 1. (page 75) Thus as each block is added it not only rests on the lower level, but against the last block. One block would simply tend to fall in, and, by experience, so do two or even three, when a new layer is started if the tiers are horizontally laid. But the Eskimo method overcomes the problem entirely.

The solution is, of course, amazingly simple – once it is known.... Most solutions are, when someone has discovered them for us! The problem is to visualize the solution before it exists. We tend to assume we would discover the way quite quickly but experience shows that this is not true. As A. H. Sayce[6] has put it so well, "one of the most significant

lessons of Archaeology is that man is not essentially creative but destructive" and among ourselves at least,"constructiveness belongs to the few."

H. M. Davies reminds us of this fact when he eloquently pointed out:[7]

> We drive an automobile because it is nearly foolproof, with little appreciation of the hidden, beautiful mechanism that powers it, and with no conception of the creative thought that went into its development: meanwhile we demand the family airplane. We listen to a radio receiver whose operation is utter magic to us and demand the even more complex television. We are a race of lever-twiddlers, button-pushers, and knob-twisters, enjoying the prodigious technical labours of a comparatively few men.

As Sayce put it in the article mentioned above,[8]

> As compared with the mass of mankind, the number of those upon whom the continuance of civilization depends is but small; let them be destroyed or rendered powerless, and the culture they represent will disappear.

But to return for a moment to the Eskimo again: because his environment offers him little in the way of raw materials, his solutions must always seem simple in nature. It is all the more to his credit that he has achieved so much. Dr. Edward Weyer in an article rightly titled, "The Ingenious Eskimo," puts the matter this way;[9]

> Take the Eskimo's most annoying enemy, the wolf, which preys on the caribou and wild reindeer that he needs for food. Because of its sharp eyesight and keen intelligence, it is extremely difficult to approach in hunting. Yet the Eskimo kills it with nothing more formidable than a piece of flexible whalebone.
>
> He sharpens the strip of whalebone at both ends and doubles it back, tieing it with sinew. Then he covers it with a lump of fat, allows it to freeze, and throws it out where the wolf will get it. Swallowed at a gulp the frozen dainty melts in the wolf's stomach and the sharp whale bone springs open, piercing the wolf internally and killing it....
>
> When the Eskimo gets a walrus weighing more than a ton on the end of a harpoon line, he is faced with a major engineering problem: how to get it from

> the water on to the ice. Mechanical contrivances belong to a world in whose development the Eskimo has had no part. No implement ever devised by him had a wheel in it. Yet this does not prevent him from improvising a block and tackle that works without a pulley. He cuts slits in the hide of the walrus, and a U-shaped hole in the ice some distance away. Through these he threads a slippery rawhide line, once over and once again. He does not know the mechanical theory of the double pulley, but he does know that if he hauls at one end of the line, he will drag the walrus out of the water onto the ice. [For illustration see Fig. 2 page 76]

The deceiving thing about his ingenuity is in its very simplicity! He makes hunting devices of all kinds, that are effective, inexpensive in time, easily repaired, and uses only raw materials immediately available. His harpoon lines have floats of blown-up skins attached, so that the speared animal is forced to come to the surface if he dives. To prevent such aquatic animals from tearing off at high speed dragging the hunter and his kayak, he attaches baffles to the line which are like small parachutes that drag in the water. A bone hoop and a skin diaphragm stretched over it, and some thongs, are all that he needs.

To locate the seal's movements under the ice he has devised a stethoscope which owes nothing to its modern Western counterpart working on the same principle.[10] And recently a native 'telephone' was discovered in use, made entirely from locally available materials, linking two igloos with a system of intercommunication the effectiveness of which was demonstrated on the spot to the Hudson's Bay Agent, a Mr. D.B. Marsh who discovered it. Marsh adds at the end of his report, this statement:[11]

> The most amazing thing of all was that no one in that camp had ever seen a telephone, though doubtless they had heard of them from their friends who from time to time visit Churchill.

Nevertheless, it is exceedingly unlikely that any such friends who had seen a telephone, would have seen the kind of arrangement this Eskimo had developed which of course used no batteries. We used to make a similar kind of thing as children with string and ordinary cans, but they were never very much use, and in any case we got the idea from someone else. In this case the Eskimo had used fur around the diaphragm tocushion it, and the sound came through remarkably well.

And finally, a word about Eskimo snow goggles. A plate of illustrations of these protective devices is given in Fig.3. (page 77) These are well known to Arctic explorers, and no one will travel in the Arctic without them – or something to replace them – if he wishes to escape the very unpleasant ailment of snow blindness. Like everything else the Eskimo makes, they are very effective, and often so designed that he does not need to turn his head to see to either side of him. This is important, since the game he usually hunts would catch the movement.

Turning now to the Indians of the Sonoran Desert, Macy H. Lapham has written illuminatingly of their genius for making much of little. He writes:[12]

> To the stranger, these desert wilderness areas seem to have little to contribute to the subsistence of the native Indian ... Notwithstanding this forbidding aspect, to the initiated there is a veritable storehouse of the desert,

> from the widely scattered resources of which essentials in food, clothing, shelter, tools, cooking utensils, fuel, medicine, and articles of adornment or those sacred in ceremonial rites have contributed for generations and still are contributing to the needs of the Indian ...

Lapham gives many excellent photographs in which various plants are identifed – and the products which the Indians have extracted from them are also listed. These lists are impressive! Thus for example he remarks:

> The desert ironwood, a small tree, is known for its extremely hard wood, is prized for the camp fire, and has been used for arrow heads and implements... The beans of the Mesquite are made into meal and baked as cakes. The split and shredded inner bark, along with similar materials from the willow and cotton wood, furnish the fibres and strands for building and for woven baskets. Some of these baskets are so finely woven that coated with gum and resins obtained from the desert plants they may be used for liquids...
>
> Condiments and seasonings for food, before the present era of the tin can were obtained from native mints, pepper grass, sage and other herbs. Ashes of the salt bush which grows in saline soils, were used as a substitute for baking powder. Other plant products containing sugar and mucilaginous substances yielded substitutes for candy and chewing gum...
>
> Wild cotton was cultivated and harvested by the Indians before the White Man and his wool-bearing animals found their way into the desert. In his arts and crafts the Indian used gums and resins from the Mesquite and the creosote bush, as adhesives; awls made from the cactus spines and sharpened bone; and dyes from species of the indigo bush, mesquite, the fetid marigold, seeds of the sunflower, and from minerals.
>
> In the absence of the family drugstore, the Indian resorted to a range of desert plants for cures of various ailments. Some of these were of doubtful value, but others are to be found on the shelf of the modern druggist. These remedies included materials for poultices and infusions, and decoctions of the manzanita, creosote bush, catnip, canaigre or wild rhubarb, verba santa or mountain balm, verba mansa, the inner bark of the cotton wood, winter fat, golden aster, golden-rod, yarrow, horsebrush, and species of the sunflower. They were used for sore throats, coughs, respiratory diseases, boils, toothaches, fevers, sore eyes, head-aches, and as tonics and emetics. Mullein leaves were smoked and used for medicinal purposes, while roots of the yucca, winter fat, and four o'clock, and leaves of the seepweed, were used as laxatives and for burns and stomach ache. There was even an insecticide – a sweetened infusion of the leaves of the

> Haplophyton or cockroach plant which was used as a poison for mosquitoes, cockroaches, flies and other pests.

Even such random excerpts from Lapham's article might be sufficient indication of the 'inventiveness' of these so-called primitive people. But there is much more to wonder at. A photograph of a Mesquite thicket in a river bed is accompanied by this observation:

> Mesquite thickets supply fuel, poles, timbers for buildings and fences, and fibres and strands for baskets and binding materials. From the mesquite's bark, seed pods, and bean-like seeds come food, browse for livestock, medicine, gums, dyes, and an alcoholic beverage.

The roots of the Yucca trees supply drugs and a 'soap substitute.' Like the pioneer farmers, it seems that they use everything but the noise! Lapham concludes:

> Thus, as the Indian made his rounds of this self-help commissary in an apparently empty wasteland, be found an impressive stock to be harvested and added to his market basket. We can only marvel at the wisdom and vast store of knowledge accumulated by these primitive people as they made the desert feed, clothe and shelter them.

This is a long quotation. But it serves to indicate what ingenuity can do with an otherwise unpromising environment. It is difficult indeed to conceive of a more complete exploitation of the primary resources of the desert in which they have been content to live.

One wonders if Lapham's use of the word 'found' is really just. They seem virtually to have exhausted their environment, extracting from it wisely, ingeniously, and effectively all it could possibly afford. Would we have 'found' much of this I wonder...

The point I should like to emphasize particularly here, is that such people, for so long supposedly unimaginative and dull, have demonstrated a remarkable genius for this kind of thing. Their ingenuity has been overlooked so often because those who surveyed their work were themselves unaware of the effort required to invent *anything*. It all seems so obvious. Their solutions to mechanical problems in particular are always characterized by a peculiar simplicity that is completely deceiving.

To digress for a moment, we may use as an illustration of this aspect of primitive technology, a method used by Polynesians to build the plank walls of their canoes. Anyone who has ever tried to bind two planks together edgewise, so that they will be tight and rigid – and will remain so – will have quickly discovered how difficult it is. It is, in fact, *almost* impossible. Yet the Polynesian canoe builders do it easily. Figure 4 (page 78) shows how it was done. In a sense, it really takes an engineer to see the genius of this. By using gums and resins in the joint, a perfectly rigid, strong, and watertight union is effected.The solution seems obvious enough. Such ingenuity was exercised where ever their comparatively simple needs were not completely satisfied because of some mechanical obstacle.

Perhaps one more such 'simple' solution may be in order here. The Indians of North America used leather for clothing – the familiar buckskin. However, one problem of all such materials is that after a while the edge begins to curl up or to roll in such a way as to be both unsightly and ill-fitting, and of course colder in winter. This was overcome by making a series of cuts into the edge and at right angles to it, each cut being about two

inches long, and spaced about one-sixteenth of an inch to one-eight of an inch apart. This imparted to the edges the familiar 'frill' effect, which is both decorative and fundamentally useful. It required virtually nothing to do it – except ingenuity in the first place. It prevents edge-curling entirely.

Desert areas always seem to hold so little promise of survival to the sophisticated European. The very appearance of barrenness seems to hinder the processes of thought which would otherwise find how to render it more habitable. But it seems to have been no great problem to non-Indo-European people, whether ancient or modern.

Recent archaeological exploration in the desert area of Transjordan has revealed a remarkable triumph of early irrigation engineering. Michael Evenari and Dov Koller reported recently on the results of their work in the Negev.[13]

> The idea that anyone could have farmed a desert as arid as this is today, seemed so incredible that many authorities concluded the climate of the region must have been more lush in the time of the Nabataeans. Nelson Glueck went to Palestine in the 1930's and to Transjordan, to re-explore the Nabataean Culture, and what he found led him to acclaim the Nabataeans as "one of the most remarkable people that ever crossed the stage of history." Their cities did indeed bloom in the midst of a seemingly hopeless desert. Nowhere in all their houses was there a stick of wood to show that any trees had ever grown in the region.

The authors then explain how these ancient people achieved a greater mastery of the desert than any other people since, and they underline the fact that the Nabataeans "avoided the mistake" of trying methods which are the universally accepted Indo-European ones, namely the use of dams. Their method was cheaper, more effective,

more readily controlled, and brought a greater area of desert land under successful cultivation. They so prospered in fact, as to be able to build and support the very famous city of Petra. The authors then describe the method of irrigation these people employed. And in summing up, they remark – to quote their own words:

> The more one examines the Nabataeans' elaborate system, the more impressed one must be with the precision and scope of their work. Engineers today find it difficult enough to measure and control the flow of water in a constantly flowing river, but the Nabataean engineers had to make accurate flow estimates and devise control measures for torrents which rushed over the land only briefly for a few hours each year. They anticipated and solved every problem in a manner which we can hardly improve upon today. Some of their structures still baffle investigators.

Records tell that the yield was often seven or eight times the sowing. As the authors conclude:

> The Nabataeans' conquest of the desert remains a major challenge to our civilization. With all the technological and scientific advances at our disposal we must still turn to them for some lessons ... the best we can do today is no more than a modification of the astute and truly mature scientfic methods worked out more than 2000 years ago by the Nabataean masters of the desert.

Snowy waste, or sandy desert, bitter cold or stifling heat – we have little to contribute in the conquest of such environments.

To return to the New World again, J. Grahame Clark, speaking of the contributions made by the Indians of North and South America to the Old World, has this to say:[14]

> Baron Nordenskiold, unlike some European theorizers, who found it difficult to credit the aborigines with the ability to raise their own civilization independently of the Old World inspiration, had spent many long and arduous years in the field of South American archaeology, and his conclusions carried with them outstanding authority. In addition to many technical inventions he attributed to the American Indian the achievement of domesticating the animal and plant life of his habitat so effectively that during the four centuries since the Discovery the White Man had failed to make a single contribution of importance. The native fauna gave poor scope, but from it he domesticated the llama, alpaca, guinea-pig, and turkey. Of plants he domesticated hundreds...

Matthew Stirling, Chief of the American Bureau of Ethnology at the time of this writing, speaks of this contribution thus:[15]

> Among the plants developed by these ancient botanists are maize, beans (kidney and lima), potatoes, and sweet potatoes, now four of the leading foods of the world. Manioc, extensively cultivated by the natives of tropical America is now the staff of life for millions of people living in the equatorial belt. Other important items, such as peanuts, squash, chocolate, peppers, tomatoes, pineapples and avocados might be added.
>
> In addition the Indian was the discoverer of quinine, cocaine, tobacco, and rubber, useful commodities of modern times. Maize or Indian corn was one of the most important contributions of the American Indian to mankind. Over a considerable portion of the Americas, it was the staff of life.

Kenneth Macgowan[16] adds to this list, the custard apple, strawberry, vanilla bean, chickle, and cascara, besides a number of others less familiar. His whole list of important plants made up by the Indian's agriculture is impressive, as he says, for it contains 50 items, not one of which is an Old World species! Every one of them can be cultivated with a hoe, requiring no draft animals whatever. He also mentions one other accomplishment which is very difficult to account for. The Indian devised a method of extracting a deadly poison (cyanide) from an otherwise useless plant, manioc, without losing the valuable

starch it contained. Macgowan says that Henry J. Bruman called this "one of the outstanding accomplishments of the American Indian." The remarkable thing about it is that they should ever have thought of making use of a plant which, as they found it, contained a deadly poison.

M.D.C. Crawford gives a list of vegetables which were cultivated by the American Indians prior to 1492, which in addition to the above are the following:[17]

aloe	Jerusalem artichoke
alligator pear	pineapple
arrowroot	Indian fig (Prickly pear)
cacao	pumpkin
chili pepper	star apple

cotton (gossypium barbadense Linn.)

J. L. Collins wrote more recently:[18]

> The pineapple shares the distinction accorded to all major food plants of the civilized world, of having been selected, developed, and domesticated by people of prehistoric times, and passed on to us through one or more earlier civilizations. The pineapple, like a number of other contemporary agricultural crops ...originated in America and was unknown to the people of the Old World before its discovery.

Just where the Indians found the original plants which they improved upon to produce modern pineapples, we do not now know. None of the existing varieties compares with the domesticated product, and as Collins observes, "none of these can be singled out now as the form or forms which gave rise to the domesticated pineapples of today, or even of those varieties in the possession of the Indians at the time of the Discovery of America." This was no accidental by-product then, but a deliberate and intelligent breeding process

which progressed so far before we knew anything about it, that we cannot now retrace the steps by which it was first accomplished.

Melville Herskovits[19] points out that the North American Indians increased the fertility of their land artificially, by putting a fish in each Maize hill, and practiced multi-planting highly successfully. In each hill planted with Maize they placed squash and bean seeds together, so that the bean plants could climb the corn stalks and the squash vines run along the ground. The same practice is apparently found in West Africa, where gourds take the place of squashes. Their reasoning here, as Herskovits points out, is different from ours: they hold that a plant which grows erect, one that climbs, and one that hugs the earth must each have a different nature and therefore extract a different food from the earth. Thus they will not compete with each other.

Speaking of the Orient, Dr. F. H. King[20] who has made a most careful examination of the farming methods practised by the Chinese, the Koreans, and the Japanese, drew special attention to their painstaking care in maintaining or enhancing the fertility of their soils using all kinds of fertilizers and other special means.

Necessity is the Mother of invention (although laziness helps!) and food is a necessity. Primitive people have shown extraordinary ingenuity in obtaining food. We have already mentioned one or two devices used by the Eskimo... the spring bone for killing wolves, for example. In other parts of the world there is the same remarkable ingenuity – and not the least remarkable element is the variety.

For example, according to George P. Murdock,[21] the Ainu of Northern Japan use dogs to do their fishing for them. There are shoals of fish in the shallow water along some of their coasts, and to catch these they have trained their dogs to swim straight out to sea in a line until a given signal. The dogs then wheel around and come back in an arc towards the shore, barking and making a big splash thus driving the fish into even shallower water where each dog seizes one in his mouth, runs ashore, and drops it at his master's feet receiving the fishes' heads as a reward!

Ralph Linton[22] speaks of one device for catching wild fowl, which he feels should certainly be awarded top prize for simple ingenuity. A flat stone of about 18" diameter is given a small raised rim of mud or clay, and certain nuts are placed in the enclosure. These nuts are a particular delight of the local guinea fowl. But the natives of several parts of Africa where these birds are found, take care to ensure that the nuts are just too large for the fowl to pick up in their beaks.

Attracted to the food, the birds try again and again to get a nut in their mouth, each time striking the flat rock with their beak instead. They are persistent creatures apparently, and so they keep it up until their beads are quite swollen and they have literally knocked themselves silly. Each day the owner of the stone calls by and picks up the stupefied birds from the immediate neighbourhood.

Poultry farmers have found that the same thing can happen to chickens fed on a concrete floor. But there is no evidence that Indo- Europeans ever put this observation to any practical use.

We may mention a further example of native ingenuity in this connection which is found in certain parts of Oceania, where there are cuttlefish which have long sucker-tipped arms that are stretched out to catch fish. The natives attach these cuttlefish to lines and use them to catch food for themselves instead.[23]

Lord Raglan tells how in some areas of Oceania, the natives of Java, of the Banda Islands, and the Dobuans, catch a particular species of fish that is difficult to approach, by using fishing-kites.[24] The kite is flown on a line of some length, and the fish hook dangles from the tail of the kite, thus allowing the fisherman to keep a considerable distance from the fish which would otherwise evade him.

It is well known that the Japanese have for years used Cormorants to do their fishing for them.[25] The birds seem to be well trained and to enjoy themselves immensely! The Samoans use a native plant drug which, when poured on the water, makes the fish dopey and easy to catch.[26] According to Carleton Coon, the Australian aborigines poison the water holes with a mild drug that similarly makes the animals who drink from them stupefied. By such means, for example, they easily catch the swift-footed emu.[27] A paper published by the Smithsonian Institution lists hundreds of such poisons used by primitive people in all parts of the world to catch game.[28]

The Terra del Fuegians have so many different traps and other devices for catching ducks and geese, etc., that it would be wearying to detail them. Coon refers to them as being many, and ingenious, and varying according to the nature of the locality.[29] They are moreover characterized by a remarkable degree of originality, so that it becomes difficult

to imagine any further alternatives. Yet these same Terra del Fuegians were considered by Darwin[30], when he visited them during his voyage with the *Beagle*, to be the very lowest of all humans – hardly people at all. Sir John Lubbock[31] shared this opinion. Yet their inventiveness where it had to be exercised knew almost no limitations. I should like to draw attention to this point, here. Inventiveness was exercised where needs arose, seldom otherwise. And this inventiveness did not (as ours so often does) display itself by merely modifying the products of others. The results were as diverse as they were original, and they are almost always characterized by a grand simplicity that is completely misleading to the Westerner whose products are so terribly complicated. Yet simplicity is the essence of genius.

Take as an illustration of this, the bola. Here is a weapon that is effectiveness itself in bringing down small rapidly moving game. The device is composed of a number of stones (usually about 2" to 3" in diam.), around each of which a cord is fastened in a groove with a free end about 12 to 18" long. From four to eight such stones form the weapon, which is made by tying together the free ends of the long cords. Holding these cords at their junction, the native swings the stones around like a windmill and lets the whole affair fly at a flock of birds, or rabbits, or other such small game. The stones tend to part company in fight, but only of course to the extent of the cords which tie them to one another. The weapon is thus widely spread by the time it reaches the game, and the chance of a hit is greatly increased. The same effect is of course obtained with 'shot.' However, if any one

of the stones makes contact or if any of the cords do, the whole weapon at once wraps itself arond the victim and down it comes! What could be simpler?

These bolas are found in many parts of the world, and even in prehistoric sites – a mute testimony to the inventiveness even of prehistoric man,[32] for it seems hard to believe that they were invented only once and that all modern instances are derivatives.

Of all primitive people, perhaps the Australian aborigines have aroused the most interest, not merely because they are so well known and among the last to retain to a large extent the greater part of their ancient skills and traditions, but also because of the extraordinary simplicity of their material culture. Virtually the whole of a man's worldly wealth can normally be carried with him, often in one hand! Of added interest, of course, is the fact they seem to be negroid (because so very black) and yet have much body hair and bushy beards – which negroes never have: thus their origin is somewhat of an intriguing mystery still.

But their ingenuity is also undoubted in so far as they have cared to exercise it. Probably the supreme example of this is the boomerang. These weapons are also found in other parts of the world, and even in prehistoric sites.[33] As a weapon, it is remarkable: and it has quite justly been called the first 'guided missile.' Of course, all thrown objects are 'guided' in a sense; but the boomerang can be so controlled in the hands of an expert that it will do extraordinary things in the air, and return to the sender if it misses the target – a great saving of effort, and a real advantage in war!

George Farwell[34] recently authored an official Australian Government paper on this device, in which the design of the weapon is carefully considered. It is a much more complex affair than would appear to the casual observer. Its response to controlled flight is outlined by the author who then explains how this is possible. It is a technical achievement of no mean order, and one wonders what was going on inside the native's mind who perfected it. Even if its special construction features were purely accidentally discovered at first, it is still true that the inventor discovered his discovery. This is not merely a play upon words. As we shall see subsequently, Indo-Europeans are still making notable discoveries and not recognizing them for what they are. Of the boomerang, Farwell writes:

> There are sound reasons for its design features. The undersides of the arms are flat, the upper have a slight camber, a factor which provides lift. There is also a twist from the horizontal at the outer end of each arm, one upward, the other down, perhaps not more than two degrees in all. It may seem unreal to discuss a prehistoric weapon in terms of aerodynamics, but therein lies the remarkable achievement of the aborigine. His practical mind and acute observation anticipated certain ideas of the 20th century aircraft designers.
>
> Sir Thomas Mitchell, the explorer, made the characteristic twist of the boomerang the basis for a new type of ship's propeller, which he patented 100 years ago. Early in this century G. T. Walker of Cambridge University, spent no less than ten years of research into the boomerang's properties, evolving certain theories on gyroscopic flight.

Farwell then elaborates somewhat on the dynamics of its flight and gives some examples of feats which the natives can achieve with very little effort. He presumes that it was perhaps by observing the flight of falling leaves with their curled up edges that the

natives came to the idea. This sounds rather weak to me. At any rate, they created a very ingenious weapon, and we have found no way to improve it yet.

George Sarton[35] uses this weapon as an illustration of "the uncanny ingenuity of 'primitive' people." To this he adds the elastic plaited cylinder of jacitara palm bark, called a tipiti, which is used to extract the poison cyanide from the Manioc to which reference has already been made. As a third illustration he refers to the prehistoric Chinese pottery vessels which took the form of a tripod, the legs of which were hollow and formed the containers. It thus anticipated by thousands of years the modern trisection aluminium wares! It is illustrated roughly in Fig. 5.(page 76.) The legs straddled the fire. The shape, of course, permitted cooking three separate dishes at one time.

In the Peruvian Andes, living at an elevation of 14,000 feet approximately, are the Aymara – believed to be the remnants of the creators of the Inca Empire. They are a rather impatient and ill-tempered people according to some observers, possibly by reason of the rarefied atmosphere in which they live, and possibly on the same account they do not care to exert themselves much to improve their condition - although obviously this was not true in the past. But they have developed their medical skill quite extensively, and so organized the Profession that there are specialists in the various fields who refer patients to one another as seems necessary.[36] Like most primitive people, they mix magic with their medicine: but they evidently realize that the magic has a psychological value as much as anything. This is true of other such native people. A. P. Elkin has written on this point at some length and is convinced that the Witch Doctor is often a man, as he put it,

of "High Degree" by which he means relatively a Ph.D. in the context of his own culture.[37] The relationship between magic and medicine, and indeed Science in general, is considered later. In the meantime it is becoming increasingly apparent that the non-Indo-European far anticipated us in their medical practice, as well as in the field of Psychology. I think this is particularly true in certain areas, such as in the problem of dealing with fear. Speaking of African medical skill, Grantly Dick Read points out:[38]

> They had cures for diseases which modern science still finds difficult to heal – and sometimes the knowledge of a good witch doctor could be of very good use to modern psychology.

Frequently, of course, they did not reflect much upon the psychology they used – but it was always very practical in its application, and it represented a kind of deep wisdom which modern physicians sometimes lack. There are often amusing and revealing illustrations of this. In two areas in particular they explored widely – in person-to-person relationships, especially with near relatives, and in dealing with the supernatural. For example, they insist as a rule that a man go to live with his wife's people. There are a number of very good reasons for this, not the least of which is the fact that they recognized that most emotional tensions revolve around the lady of the house. When a man goes to his wife's home, the lady of the house 'gains' a son. If, however, the wife goes to the husband's house to live, the lady of the house 'loses' a son! This is a serious thing – the root of much jealousy and causes emotional tensions which they sought to avoid.

As an illustration of the second area in which Psychology is applied, one can cite a case that occurred in a Pueblo village after the last war. Many young Hopi volunteered

for service overseas. This often badly confused their traditional cultural behaviour patterns. One anthropologist noting this, suggested to a young Hopi veteran that he'd still be afraid to sleep in one of their ancient cemeteries. He laughingly denied this. So he, and an old villager, agreed to the test. The old man selected a spot to sleep, performed several little rites, sprinkling seed around his bed and urinating on the seed. With a brief prayer, he then lay down and slept like a child. The young man no longer believed in such things – neither the spirits (so he said) nor the 'magic.' He tossed and turned, quite unable to sleep – pretending to be unafraid and having no longer any accepted means to offset the fears he denied. He finally got up and returned to the village! A. P. Elkin gives many instances of this kind of thing in Australia, and says that he often spoke to the old men about their faith in the magic they used and was surprised to find how clearly they understood its psychological value. Some of the witch doctors were Ph.D.'s in Psychology, rather than doctors with an M.D., according to Elkin.

But even in the use of drugs that do actually work chemically the non-Indo-European has been far ahead of us. Aldous Huxley speaks of the use of such drugs and tranquillizers and other remedies for anxiety:[39]

> Certain chemical compounds produce certain changes of consciousness and so permit a measure of self-transcendence and a temporary relief of tension. Thus, the so-called "tranquillizing drugs" are merely the latest addition to a long list of chemicals which have been used from time immemorial for changing the quality of consciousness and so making possible some degree of transcendence. Let us always remember that, while modern pharmacology has given us a host of new synthetics, it has made no basic discoveries in the field of the natural drugs; it has merely improved the methods of extraction, purification, and combination.

> All the naturally occurring sedatives, narcotics, euphorics, hallucinogens, and excitants were discovered thousands of years ago before the dawn of civilization. This surely is one of the strangest facts in that long catalogue of improbabilities known as human history. Primitive man, it is evident, experimented with every root, twig, leaf and flower, with every seed, nut and berry, and fungus, in his environment. Pharmacology is older then agriculture. There is good reason to believe that even in Palaeolithic times, while he was still a hunter and food gatherer, man killed his animals and human enemies with a poisoned arrow. By the Stone Age he was systematically poisoning himself. The preserved heads of poppy in the kitchen middens of the Swiss Lake dwellers shows how early in his history man discovered the techniques of self-transcendence through drugs. There were dope addicts long before there were farmers.

As an example of the extent to which such people go, it may be mentioned that the Jagga even developed truth serum![40]

Claude Lévi-Strauss underscores another aspect of this psychomedical contribution:[41]

> The West, for all its mastery of machines, exhibits evidence of only the most elementary understanding of the use and potential resources of that super-machine, the human body. In this sphere on the contrary, the East and Far East are several thousand years ahead; they have produced the great theoretical and practical summae represented by Yoga in India, and Chinese 'breath techniques,'" or the visceral control of the ancient Maoris...
>
> In all matters touching on the organization of the family, and the achievement of harmonious relations between the family group and the social group, the Australian aborigines, though backward in the economic sphere, are so far ahead of the rest of mankind that, to understand the careful and deliberate system of rules they have elaborated, we have to use all the refinements of modern mathematics ....
>
> The Australians with an admirable grasp of the facts, have converted this machinery into terms of theory, and listed the main methods by which it may be produced, with the advantages and the drawbacks attaching to each. They have gone further than empirical observation to discover the laws governing the system, so that it is no exaggeration to say that they are not merely the founders of modern sociology as a whole, but are the real innovators of measurement in the social sciences.

Not all sociologists would agree with Lévi-Strauss, of course, but there is no doubt that the social aspect of human relationships have here been subjected to unusual scrutiny. It seems almost a rule, in fact, that the simpler the culture in its materials, the more elaborate its formalized social structure is apt to be, including its rituals. And conversely, the more complex the civilization, the less formal its social patterns are likely to be. Ralph Linton[42] speaks of one occasion in an Australian tribe, where it happened that the regulations had become so involved that a time came when it was found nobody could properly get married any more!

All the American Indians had an extensive medical knowledge. Their surgical skill was remarkable, and like non-Indo-Europeans in many other parts of the world, ancient and modern, they practised such delicate operations as trepanation with remarkable success.[43]

Such extremely delicate surgery implies the use of some kind of anaesthetic. Robert Lowie[44] reminds us that we owe this very fundamental discovery to the South American Indian. As he says, "What is absolutely certain is that our local anaesthetics go back to the Peruvian Indian's coca leaves, whence our cocaine."

Another important invention from the same source is the enema. Robert Heizer, in an issue of a well-known publication which was devoted to the history of this instument, states that:[45]

> The medical practices of the Indians of North and South America prior to the shattering of their cultures by Caucasian wars and exploitation, were truly amazing in their magnitude and excellence. Our fractional knowledge of these attainments derives from early historical records, ethno-botanical works by botanists and pharmacologists, and from intensive study of skeletal materials by

> trained observers. Included in the roster of medical techniques was the administration of enemas and lavements by means of a number of instruments – bulb and piston type syringes and clyster tubes.

Nordenskiold[46], speaking of the American Indian as an inventor, refers to such enema syringes, one of which he illustrates. The illustration, Fig. 6, (page 83) is taken from his work, and shows how little we have been able to improve upon it! Even the decorative scheme is in excellent taste, and the mode of manufacture was copied exactly when Indo-Europeans first began to exploit the native development of rubber latex.

The same writer also mentions the invention of tweezers for medical purposes for which he gives the credit to the Araucanians, another Peruvian tribe. The Jivaro Indians use the pincers of living ants for the purpose of suturing wounds – a most extraordinary procedure that has been observed in other parts of the world also.[47] The skin is drawn together, the small ant so applied that it seizes the suture and hold it tightly closed in its strong mandibles, and then the animal's body is quickly snipped off! So the series of fine pincers along the wound hold the skin lesions together till healing takes place. Erwin Ackernecht[48], in writing of this interesting technique, concludes that it is a witness to "the great inventive power that the 'savage' develops in all those fields that he deems worthy of interest."

We have mentioned rubber enemas. According to Nordenskiold, there appears to have been a secondary development arising out of the making of hollow rubber balls for games.[49] Such balls were made by forming a core of clay or some such material and then dipping this repeatedly in a solution of latex allowing each coating to dry before applying

the next one. When the skin was thick enough, a small round hole was cut through the rubber to the clay core and the latter was removed through the hole, a small amount at a time. The hole was then plugged with another wad of latex, in a semi-hard condition, and the whole redipped once more in latex thus sealing the air inside the ball. Solid balls were also made, which weighed as much as 25 pounds. These were used in the well-known games played by the Maya in such open courts as have been found at Chichen Itza, Mexico, and elsewhere.

An article in a rubber journal recently pointed out that these balls are only one example of the use made by the American Indian of this plastic material.[50] He also made watertight shoes, flasks, ponchos, and dolls. The same article states that:

> The development and use of natural rubber by the American Indian is impressive, for in 300 years his "civilized" conquerors made little improvement in the ancient method of rubber manufacture.

The natives used a certain sap of a vine (Iponoea bona-nox) or from a liana (Catonyction speciosum) to coagulate the latex. Certain trees have the latex in a form which is rubber in suspension in water. The water can be evaporated and the rubber remains, without any need for a catalyst.

The story of Charles Goodyear's efforts to take over the development of rubber from the natives of Brazil and exploit it in America and elsewhere, is well known. The problem was to treat it so that it would retain its structure even in hot weather. Their own rubber served the Indians well enough, especially since they had the secret of curing it by using

local products as catalysts. Goodyear, again and again, brought himself, his family, and his backers to the point of ruin and bankruptcy because he could not cure the stuff out of which he was trying to make raincoats, mail bags, and overshoes. As soon as warm weather came, his products turned into a sticky useless mess! Of course he finally discovered how to cure by vulcanizing, using sulphur as a catalyst.[51] But it seems probable that many of his heartbreaks never would have occurred if he had gone back to the originators of rubber articles and asked them to teach him what they knew first.

Moreover, it is very doubtful if Goodyear or anyone else of his cultural background would have seen, in the Brazilian forest, what the natives had seen, i.e., a natural product requiring only to be treated with another natural product to supply a remarkably versatile and useful material.

In the matter of Textiles, we have been borrowers in almost every detail. It is considered by G. P. Murdock that the Central American Indian excelled here also:[52]

> In skill and technique in the textile arts the ancient Peruvians have had no equal in human history. They wove plain webs, double faced cloths, gauze and voile, knitted and crocheted fabrics, feather work, tapestries, fine cloths inter-woven with gold and silver threads – employing in short, every technique save twilling known to the Old World, in addition to some peculiar to themselves... They employed methods identical with those used in the famous Gobelin and Beauvais tapestries; they nevertheless in harmony of colours, fastness of dyes, and perfection of technique, far surpassed the finest products of Europe.

C. Langdon White[53] says that the best of their fabrics were from the wool of the vicuna, softest of all animal fibres, with 270 threads to the inch as compared with 140 threads otherwise considered to be outstanding.

M.D.C. Crawford writing in 1948 before certain very recent developments underscores this achievement of the Indian. He made a particular study of this aspect of their art and skill, and concludes:[54]

> As a matter of fact, Europe has never produced a single original natural textile fibre or any dye except perhaps wool. She has not contributed a single fundamental or original idea to the basic mechanics of textiles, nor a single original and fundamental process of finishing, dyeing, or printing....
>
> In the broader world history of textiles and cloth, the ingenious English inventions of the 18th century (led by Kay's fly-shuttle) are but incidental mechanical modifications and developments of older ideas which grew out of the social conditions in England, and were directly due to the importation of cotton and silk fabrics from the Far East during the 16th and 17th centuries. No new basic principles either in spinning, weaving, or fabric construction, nor new methods of decoration, dyes, colours, or designs, are involved in the English machines. The ancient principles of twisting and elongating masses of fibre into yarn, the principle of interlacing one set of filaments held in place between parallel bars of a second set of filaments, remains undisturbed. No new raw materials are involved: flax, hemp, wool, cotton, and silk, remain the principle fibres. And for colour the dyes of antiquity were still employed. As a matter of fact, all the dye raw materials of antiquity, both from Asia and America, were still mentioned In English dyer's manuals in the late part of the 19th century, and years after Perkins experiments with coal tar derivatives in 1856.

Silk of course came to us from China, felt from Mongolia,[55] materials made from pulps were developed in Polynesia (tapa cloth, etc.). These last are coming into their own in our day, the capacity for greater production being about our only claim for credit. And even here, the claim may be somewhat premature, because considerable difficulty has been experienced thus far in the manufacture of such materials on a large scale. The native products are hand made of course. Moreover their methods of decoration, by tie-dyeing,

batique, and silk-screen, are simply not applicable to mass production methods at present. We do not have time for tie-dyeing.

Moreover, as we shall see when we come to consider the textile 'industries' of ancient Sumeria, virtually the whole concept of mechanization, of large mills and hundreds of specialized workers each doing a single kind of operation, was well developed at least five thousand years ago in the Middle East.

Meanwhile the Egyptians succeeded in weaving such fine fabrics that they are still equal to our own best products woven by the very latest mechanical means. Some of the garments associated with King Tutankhamen's tomb have 220 threads to the inch as shown in Fig. 7. (page 79) Common handkerchiefs today, of linen, show only about 60 to 70 threads per inch and good linen cloth for such purposes seldom has more than 100 threads per inch, or less than the Egyptian prototype.

Their pottery has always been a source of amazement, whether in the New World or the Old. Chinese pottery has long been prized for its beauty in form, colour and texture. Central American pottery is remarkable for its complete freedom of form, and for its ingenuity also. In an environment where evaporation rates are high, it is desirable to cut down the size of the opening at the top. But this makes pouring more difficult. The air rushing in suddenly causes the water to flow out unevenly, and to spill easily. But in many places water is too precious to be wasted in this way. The Peruvians and the Maya overcame this by putting two spouts on the pot so that one became both a handle and a separate air inlet. The variations of this theme were both ingenious and aesthetically

pleasing. Not content with this, they even went further and so designed the passages that when water was poured out, the air rushing in caused a whistle to blow. In some cases it is difficult to see why this was done, unless it was to warn the adults when the children were robbing them of a rather precious commodity! Other types seem clearly to have been whistling 'kettles' – a further effort to conserve waste by warning the lady of the house that the water was boiling away.[56]

Many of their vessels are shaped as heads, faces, animals, and even whole people. And these reproductions were not approximations. They were so lifelike in many cases that they must surely have been actual portraits. Their artistry and skill seem to have known no limits.

The same is true of Middle East pottery. In Minoan Crete the wares are of such delicacy that it seems they must be copies of originals made in hammered metal. Even the 'rivets' are indicated sometimes. They also reveal that the metal prototypes were sometimes formed by a process akin to deep drawing as we technically understand it now. Some of the pottery from the earliest levels at Tell Halaf and Susa is astonishing in its complete freedom of form and unbelievable delicacy. We shall refer to this subsequently.

Ancient High Civilizations

The fame of the Central American Indians in the matter of road building has been well reported. Cement pavements and other types of surfaced roads; suspension bridges spanning up to 450 feet, anchored at each end by massive stone pillars and capable of

carrying cattle and pack animals, were built in some of the most rugged country in the world. These bridges were often 6 to 8 feet wide. The ropes by which they supported these slender structures are known to have been up to 12" in diameter.[57] One of the most famous builders was the Inca, Mayta Capac, who is generally dated from 1195 to 1230 A.D. Although they used wheels on toys, for some reason they did not employ wheeled vehicles. At least there are no remains of them, nor pictures, nor references in their traditions or literature. Yet they did use road-rollers weighing up to 5 tons![58] One of these is illustrated in Fig. 8 (page 80) In Fig. 9 (page 81) is shown a reconstruction of a suspension bridge. Moreover they had extensive postal systems along these highways, and an excellent quality of paper for writing letters and keeping records.

Archaeologists have discovered that the Maya were making true paper approximately 3000 years ago.[59] Before these artisans disappeared, the Aztecs had learned the secret. This same process was handed down from generation to generation and today is used by the Otomi Indians in Mexico. The inner bark of the fig tree is soaked in running water until the sap jells and can be scraped off. The fibrous residue is then boiled in lime, washed once more, and laid on a flat wooden surface like a bread board, where it is pounded to a pulp. The pulp is left on the board and sun dried. The ancient Aztecs went one step beyond the 20th century Otomis. Their process was identical up to this point, but after the paper was dry they sized it, then calendered it with hot stones to produce surfaces readily adaptable for printing. They then printed on it with a crude kind of moveable type!

Although many of these original developments have long since been lost sight of, there still remains sufficient on record to suggest that in Central America a stage of technical excellence had been achieved and natural resources exploited, mathematics developed (including the use of zero and a place system for numbers) the development of a literature (among the Maya at least), and a leisure class, that the advance into Science should have been made. Gilbert Lewis says:[60]

> Probably the most remarkable achievements of the American Indians, were in the fields of arithmetic, astronomy, and the Calendar. Two of the greatest inventions of arithmetic, the zero and the sign of numerical position, were regularly employed in America long before they are known to have occurred elsewhere...
>
> It may be noted that few apparently unrelated items which I have discovered in the literature may, when put together, suggest the possible use of astronomical instruments in early America. Both in Mexico and in Peru concave mirrors were found, articles that had not been seen in Europe at the time of the Conquest. In Peru, these concave mirrors were employed in a solar rite. Periodically all old fire was extinguished and a new fire was started by the priests who, with these mirrors focused the rays of the setting sun on a wisp of cotton. Among the Aztecs new fire was produced at night by the fire drill. However, that they had recollections of a practice akin to the Peruvian is suggested by the name of one of their chief gods "Smoking Mirror."

Speaking of Peruvian surgery, J. Alden Mason, quoting the well known paleopathologist R. L. Moodie, says:[61]

> I believe it to be correct to state that no primitive or ancient race of people anywhere in the world had developed such a field of surgical knowledge as had the pre-Columbian Peruvians. Their surgical attempts are truly amazing and include amputations, excisions, trephining, bandaging, bone transplants (?), cauterizing and other less evident procedures.

He then speaks of the use of anaesthetics and possibly hypnosis. He remarks that some skulls show the result of operations on the frontal sinus. Their 'operating rooms' were first cleared and purified by the sprinkling and burning of maize corn-flour, first black and finally white.

Mason considers that it is literally impossible to exaggerate the technical achievements of these Peruvian highlanders in the field of textiles. He holds that it is not the view merely of enthusiastic archaeologists, but of textile manufacturers themselves. Their skill he terms 'incredible.' They even had invisible mending in place of patching. The Aymara still do! In metallurgy they were not far behind.

Among their textiles, according to Mason, have been found "twining, plain cloth, repp, twill, gingham, warp-faced and weft-faced or bobbin pattern weave, brocade, tapestry, embroidery, tubular weave, pile knot, double cloth, gauze, lace, needle-knitting, painted and resist-dye decoration and several other special processes peculiar to Peru and probably impossible to produce by mechanical means." It is even possible that they may have watered some crops with coloured liquids to produce naturally dyed fabrics that were indeed sun-worthy!

Nor is this inventiveness limited to Central America, although for climatic reasons this may have been the best environment to encourage high civilizations. The Iroquois had invented 'rifled' arrowhead long before they found themselves face to face with or in possession of rifled fire arms.[62] It does not seem likely that the spiralling is sufficient to rotate the arrow rapidly enough that the need for feathers is eliminated. This at least has

not proved to be the case with my own sample. Evidently such was not the objective. What is clearly achieved is a far more serious wound. Like the outlawed dum-dum bullets of World War I, the form of the head is such that the arrow does not pass right through (where it could easily be withdrawn) but buries itself in the flesh and stops there. The energy of the arrow is absorbed as the head 'corkscrews' into the body.

The Aymara of Peru build sailing boats and use them on lakes two and a half miles above sea level – yet there is scarcely a tree to be found at this elevation. These vessels are made entirely of local bulrushes, and even the sails are mats woven from the same materials. The masts are built up of small pieces of wood spliced together. Provided these vessels are permitted to dry out every little while, they will carry a considerable load.[63]

The pre-Inca Indians were master architects, building great monuments and immense fortifications of stones set in to each other by being laid and lapped together right on the spot. How they were erected is still a mystery, for many of the stones are huge. But this certainly is the only genuinely earthquake-proof architecture in Middle America! For an illustration of one of the most famous such fortifications (?) see Fig.10.(page 82)

One of the most surprising things about the great Ball Court of Chichen Itza is its acoustical properties. Recently the Editor of an American magazine visited this court and reported on this unexpected feature. He wrote:[64]

> We climbed to the vantage point of one of the stands for the thrones of the priests at the southern end, while our guide went to the other. We were five hundred feet apart. We talked in low tones no louder than a couple would use sitting in the living room of an average home. We could hear each other perfectly.

> We reduced our voices to a mere murmur: we could still hear each other perfectly...
>
> The General Electric Company, we were told, brought a large group of engineers to Chichen Itza to carry on acoustical experiments in the big ball court. They attempted to duplicate the court elsewhere but did not get the same acoustical effect because they had not built with limestone.

The tools of the pre-Columbian builders were no less remarkable than their buildings. It is believed now that they may have used glass cutting edges for saws, etc., in place of steel – the glass being a natural volcanic residue. Recent experiments demonstrate that such tools can be most effective. The idea is suggested by the form of certain fighting weapons.[65]

They had even developed a specialized form of dental repair, using a kind of Portland Cement filling which has remained firm and intact in tooth cavities for 1500 years! Of this discovery Sigvad Linne remarks,[66]

> The findings (of archaeologists) have revealed to us some of the inventiveness and technical skill possessed by the Indians. The practical aids of these unknown technicians may have been primitive yet it could scarcely have been "primitive peoples of nature" that with such simple means achieved results before which their later born Swedish colleagues sometimes stand in dumb amazement.

This is a digression, but one might mention that a recent report from Washington states that there is now evidence of the habitual use of some kind of cleaning agents on the teeth of prehistoric skulls.[67] Since the Chinese had by at least 1500 A.D. developed a tooth brush that looks remarkably like its modern counterpart, there is surely nothing new under the sun![68] For a picture of this toothbrush, see Fig.11.(page 88).

Nordenskiold[69] adds to the credit of the America Indians the invention of the hammock (New Guinea), children's go-carts (North-western Brazil),[70] cigar holders,[71] the chain,[72] and an ingenious self-acting water-pump (Columbia) which the Spaniards adopted and converted into a bilge pump.[73]

It could become just an endless catalogue if we were to go on listing isolated instances of native ingenuity such as the use of the skin of the ray-fish by the Polynesians as a 'sand paper';[74] the use of giant fireflies called Cucuyo and tied to the feet by the natives in the West Indies to light their way along jungle paths at night,[75] and so forth.

So much importance is attached to inventors and their inventions, that they were held in great veneration and quite often were ultimately deified. The only encyclopaedias the Chinese had originally dealt with the heroic figures who were famous because they had invented something.[76] Indeed in some cultures, this kind of talent is so generally expected of the males that the would-be son-in-law must win his bride by performing some almost impossible task set by the family, which calls forth nothing short of inventive genius![77] Perhaps this is not such a remarkable circumstance in a way, since we are tending to move in the same direction and devote more and more space in encyclopaedias to inventions. Yet scholars and generals, poets and artists, politicians and sportsmen, still share the pages of our history books with equal recognition.

At any rate, we can see that such an aptitude for invention, and the ability to exploit the natural resources of the environment, was encouraged only so far as the overall economy allowed. There was no leisure, often little security, not much accumulation of

wealth, and frequently insufficient 'sophistication' to suggest to such people that they might go further. To a man who can hardly keep food in the larder for his family, idle curiosity is not likely to find much encouragement. These people searched, and found the immediate solution: but they did not have the energy, the need, the time, or the will to re-search and extend the answers they had found once they proved effective enough. They have searched. We *re*-search.

But surely this was not true in China, or Sumeria, or Egypt or Crete, or the Indus Valley, or in Anatolia? Why did not these much more advanced and highly organized Cultures progress further? Why did they not explore their own well-developed technology and proceed to a Scientific Age? The climate was suitable, records were extensive, and natural resources were abundant enough in many cases.

Let us examine their achievements and (since we have the means to do so) explore their underlying philosophy as revealed in their literature; for, unlike cultures so far considered, they all developed writing very early in their history, and their educated sons left many records of their thoughts, as well as their business documents, and their royal chronicles of inventions and of conquests.

Ancient High Civilizations

There is little doubt that the basic culture in Sumeria (and later on, in Babylonia and Assyria), in Egypt, and in the Indus Valley, in Northern Syria and in Crete, were all non-Indo-European. The Indo-Europeans were in fact not the creators of the cultures

they subsequently became so indebted to, but rather – as Vere Gordon Childe[78] put it – the destroyers. Certainly this was true in the Indus Valley where they are first known from history as an organized body. China makes her great contribution to Indo-European Culture somewhat later, and can therefore be considered last.

The basic elements of Mesopotamian civilization in later times when the Babylonians and Assyrians (both Semitic in origin) had achieved ascendancy, were still essentially Sumerian. It is pretty well agreed that these Sumerians were not Semites, being clean shaven and comparatively hairless like the Egyptians. And from their language it is quite clear that they were not Indo-European either. Their civilization developed very rapidly and achieved a remarkable level of technical competence. In the earliest stages of their history, they seem to have shared many features with the Indus Valley people who were later overwhelmed by the Aryans, and with the first settlers in Northern Syria, and even with the earliest Egyptians. As further development took place in each of these areas, cultural similarities became obscured.

All these cultures seem to spring into being already remarkably well organized, with skills in weaving and pottery making, and in the erection of defensive structures and temple buildings, and with some use of metals from the first. It is assumed that the Sumerians were organized into city-states before the Egyptians were, although it was once held that the oldest centre of civilization was along the Valley of the Nile. While there is, as yet, no evidence of the Sumerians without the basic elements of civilization it is believed that they came from the North and East, and it is expected that the origins

of these people (and of the Egyptians and Indus Valley people also) will in due time be discovered in the general direction of Jarmo, Sialk, etc. What is now fairly clearly established is that civilization – the arts and trades and organized city life, with the division of labour, social stratification, a leisure class, written records, and so forth – began, in so far as the Middle East is concerned, with the Sumerians.

Vere Gordon Childe put it this way:[79]

> On the Nile and in Mesopotamia the clear light of written history illuminates our path for fully 50 centuries; and looking down that vista we already descry at its farther end ordered government, urban life, writing and conscious art. The greatest moments – that revolution whereby man ceased to be purely parasitic and, with the adoption of agriculture and stock raising, became a creator emancipated from the whims of his environment, and then the discovery of metals and the realisation of their properties, have indeed been passed before the curtain rises.

And T. J. Meek confirms this by saying:[80]

> The Sumerian Culture springs into view ready made, and there is as yet no knowledge of the Sumerians as savages; when we find them in the 4th millennium B.C., they are already civilized highly. They are already using metals, and living in great and prosperous cities.

This is not a study of archaeology strictly speaking, and one cannot therefore digress into elaborate descriptions of the results of excavation in the Middle East. It can however be safely stated – because easily defended – that the most surprising aspect of the whole venture has been the discovery that technical skill seems to have been remarkably high from the very beginning and to have been applied in the fields of metallurgy, building, weaving, agriculture, medicine, art, pottery and ceramics, and transport (both on land and water) from the earliest times. In fact succeeding ages did not reach the same high

standards as a rule. The problems of design, basic materials, methods of production in 'quantity,' control of quality, marketing and cost accounting – all these aspects were successfully dealt with in ways that have been very little improved upon since.

A quotation from Abbott Payson Usher seems appropriate here:[81]

> In this connection it may be well to emphasize the fact that there is no direct connection between the character of the tools and mechanisms used and the quality of the craftsmanship. The highest quality of work has been done with the simplest appliances. Ancient gem cutting was, on the whole, superior to the modern work. So, too, periods of technologic advance are not necessarily periods of improvement, in the style or finish of the work. Many of the misconceptions of the technique of antiquity are due to the naive assumption that good work implies elaborate tools and mechanisms ...
>
> More frequently, technologic advances merely reduce costs and open up possibilities of a larger volume of production.

The Sumerians knew what percentages of metals to use to achieve the best alloys, casting a bronze with 9 to 10% of tin exactly as we find best today; their pottery was often paper-thin, tastefully shaped and decorated, and with a ring like true china evidently having been fired in controlled-atmosphere ovens at quite high temperatures. Their methods of production led very early to a measure of automation including powered agricultural equipment that was in the strictest sense 'mechanical' (Fig.12 page 83); the control of quality production was early established by systems of inspection; their factories were highly organized and price controls and wage controls were established by law. They developed loan and banking companies where interest rates were outlandish, yet still legally controlled; their record keeping and postal systems were highly efficient, mail being carried in envelopes!

In addition the upper classes lived quite sumptuously, well supplied in many cases with home comforts and 'all modern conveniences' – including running water in some cases, tiled baths, proper disposal of sewage, extensive medical care, and so forth. Even libraries existed, and well organized schools of course. By comparison their descendants did not sustain their inheritance, but came to live in that filthy squalor, precarious poverty, and constant threat of disease, which misled earlier generations of Europeans to suppose mistakenly that they themselves were the creators of the superior civilization they were enjoying.

The greatness of Egypt today is 'monumental.' Sumerians did not build with stone, for they did not have it in sufficient quantity. They left another kind of monument – imperishable written records. Once these began to be deciphered something of their achievement became apparent. It is by such means that we know for example of their mathematics. Dr. T. J. Meek tells us that:[82]

> Like the Egyptians the early Sumerian used the additive method to multiply and divide, but before 2000 B.C. they had evolved multiplication tables and tables of reciprocals and of squares and cubes, and other powers, and of square and cube roots and the like. They had attained a complete mastery of fractional quantities and had developed a very exact terminology in mathematics. The correct value of Pi, and the correct geometrical formula for calculating the area of rectangles was known before 3000 B.C., and in the years that followed came the knowledge of how to find the area of triangles and circles, and irregular quadrangles, polygons, and truncated pyramids; also cones and the like. By 2000 B.C. the theorem attributed to Pythagoras was familiar and they could solve problems involving equations with 2, 3, and 4 unkowns.

According to one of the best authorities in this area, they even had developed an equivalent to our logarithm tables![83]

George Sarton, writing some 20 years later than Meek, could add to this accomplishment their knowledge that the angle in a semi-circle is a right-angle, that they could measure the volume of a rectangular parallelepiped, of a circular cylinder, of the frustum of a cone, and of a square pyramid. He sums up the achievement thus:[84]

> The Sumerians and their Babylonian successors left three legacies, the importance of which cannot be exaggerated: 1) The position concept in numeration. This was imperfect because of the absence of zero: (2) the extension of the numerical scale to sub-multiples of the unit as well as to the multiples. This was lost and was not revived until 1585 A.D. with reference to decimal numbers: and, (3) the use of the same base for numbers and metrology. This too was lost, and not revived till the foundations of metric system in 1795.

Later, he writes of what we borrowed indirectly from this source:

> Many other traces can be detected in other cultures, even that of our own today – sexagesimal fractions, sexagesimal divisions of the hours, degrees, and minutes, division of the whole day into equal hours, metrical system, position concept in writing of numbers, astronomic tables. We owe to them the beginnings of algebra, of cartography, and of chemistry.

But perhaps the greatest surprise of all is to find that the Greeks did not do so very well transmitting this heritage usefully! Thus Sarton concludes:

> The Greeks inherited the sexagesimal system from the Sumerians but mixed it up with the decimal system, using the former only for sub-multiples of the unit, and the latter for multiples, and thus they spoiled both systems and started a disgraceful confusion of which we are still the victims. They abandoned the principle of position, which had to be reintroduced from India a thousand years later. In short their understanding of Babylonian arithmetic must have been very poor, since they managed to keep the worst features of it, and to overlook the best ...
>
> The Greeks used their intelligence in a different way and did not see simple [*i.e., practical - ACC*] things that were as clear as day to their distant Sumerian and Babylonian predecessors.

It might be thought that if the Sumerians were really practical people they would have adopted a decimal system from the first, and quickly abandoned the sexagesimal system. But there is much to be said for the use of 12 instead of 10 as a base number. Ten has only two factors, 2, and 5. But 12 has 2, 3, 4, and 6, or twice as many: and in the higher multiples such as 60, the number of factors is of course greater than the corresponding 20 of the decimal system. Learning to think in terms of such a system would be difficult for us now that we are so accustomed to the decimal system, but there are some highly competent mathematicians who hold that the change could be made and would be advantageous. This is a matter of opinion of course, but since we have 10 fingers the choice of 10 as a base seems more obvious – and one suspects therefore that these practical people saw a real advantage in using 12 instead.

Yet it was purely a practical matter, and not a theoretical one. The Greeks were more interested in theory than practice. The contrast between the Sumerian and the Greek attitude is seen in their treatment of problems of Astronomy. In this connection, O. Neugebauer says:[85]

> A careful analysis of the assumptions which must be made in order to compute our texts shows nowhere the need for specific mechanical concepts such as are familiar to us from the Greek theory of eccentrics or epicycles, or from the corresponding planetary models of Tycho Brahe or Kepler ... At no point can we detect the introduction of an hypothesis of a general character.

Samuel Kramer[86] makes frequent reference to the fact that the Sumerians were an entirely practical people, with no urge to search for truth for its own sake, among whom

there was not the slightest tendency either to theorize or generalize, who sought for no underlying principles, and undertook no experiments for verification.

Sarton gives some illustrations to show how their mathematics arose out of a practical need, i.e., business records and transactions. In the same way geometry reached the Greeks after being developed to satisfy entirely practical needs of the Egyptians. This is why Thales termed it Geometry, for it was required originally to measure the land in order to re-establish property boundaries obscured each year by the flooding of the Nile.[87] Among the Sumerians and Babylonians, banking houses sprang up and became the forerunners of world economics as represented by our international institutions. Two such Banks are known from cuneiform records by the names of Engibi and Sons, established about 1000 B.C. and lasting some 500 years, and Murasha Sons, founded about 1464 B.C.and dissolved finally in 405 B.C. The latter established a system of mortgaging![88] Glass was known to the Sumerians by 2700 B.C., and both they and the Egyptians were experts in the working of it.[89] For drilling such hard substances they used diamond drills, or some soft material coated with emery or corundum.[90]

A tablet found a few years ago is inscribed by a certain Dr. Lugal-Edina, dated about 2300 B.C., and in it we are told how surgeons of the day had already learnt to set broken bones, make minor and major incisions and even attempt operations on the eyes. Sicknesses are given names, and symptoms carefully noted. Waldo H. Dubberstein of the Oriental Institute of the University of Chicago, in reporting on this says:[91]

> One hundred years of exploration and research in the field of ancient Near Eastern history have yielded such astounding results that today it is unwise to speculate on the further capacities and resources of these early people along any line of human endeavour.

Medicine was a carefully regulated profession with legally established fees for various operations and very stiff penalties for failure or carelessness – evidently intended to protect the customer and prevent charlatanism. This certainly suggests that the profession was not simply a 'School of Magicians.'

Although their buildings have largely disappeared, they were noteworthy examples of the use of local materials, i.e., mud-dried brick and reeds. The former are easily visualized as promising materials; the latter are not. But as a matter of fact, "reed huts" (mentioned in some of the very earliest tablets are capable of a surprising beauty and spaciousness as the accompanying illustrations indicate. (Fig.13 page 84 and Fig.14 page 85) These are modern examples of course, but there is every reason to believe that the designs have not greatly changed through the centuries that intervene. Floor plans as revealed by excavation indicate similar structures.

By the time the Sumerians arrived in Mesopotamia, they had domesticated as many animals as were ever domesticated in that area, with the exception of the horse which was tamed by the Hittites – although they did have a draft animal, a mountain ass. And the same may be said of grains. N.I.Vavilov always considered that the Highland Zone to the north and east whence they had come, was for this reason the most likely home of all such

domesticated plants and animal species as are commonly in use today. He called it the "Source of Species."[92]

Written records appear at the very earliest levels, and even at Sialk there seems to have been no period when they were without the use of metals.[93]

The same story is found to be true of Egypt. Here again there is no true beginning. The Egyptians, like the Sumerians and the founders of Tell Halaf in Northern Syria, appear to have been culturally creative from the very beginning, and to have developed their technology exceedingly rapidly. Pastoral societies are slower to develop, and the Semites who were largely pastoral contributed little and borrowed much. Indo-Europeans meanwhile did not even have a word of their own for "City," the organization of urban community life with all that this entails in terms of civilization did not originate with them. It has been shown that all their words for City, Town, etc., are loan words.[94]

The speed with which Egyptian civilization developed was astonishing. P.J. Wiseman, who has spent a lifetime in the area studying its past history and closely in touch with the work of archaeologists, says in this regard:[95]

> No more surprising fact has been discovered by recent excavation than the suddenness with which civilization appeared.... Instead of the infinitely slow development anticipated, it has become obvious that art, and we may say "science" suddenly burst upon the world. For instance, H. G. Wells acknowledges that the oldest stone building known is the Sakkara Pyramid. Yet as Dr. Breasted points out, "from the Pyramid at Sakkara to the construction of the Great Pyramid less than a century and a half elapsed."

Writing of the latter, Sir Flinders Petrie stated that:[96]

> "The accuracy of construction is evidence of high purpose and great capability and training. In the earliest pyramid, the precision of the whole mass is such that the error would be exceeded by that of a metal measure on a mild or a cold day; the error of levelling is less than can be seen with the naked eye."

The same famous Egyptologist stated that the stone work at the Great Pyramid is equal to optician's work of the present day. The joints of the masonry are so fine as to be scarcely visible where they are not weathered, and it is difficult to insert even a knife edge between them.

Vere Gordon Childe, speaking of their earliest earthenware remarks:[97]

> The pottery vessels, especially those designed for funerary use exhibit a perfection of technique never excelled in the Nile Valley. The finer ware is extremely thin, and is decorated all over by burnishing before firing, perhaps with a blunt toothed comb, to produce an exquisite rippled effect that must be seen to be appreciated.

J. Eliot Howard[98] states that the hieroglyphics of the earliest periods indicate that pottery, metallurgy, rope making, and other arts and techniques were well developed, and

W. J. Perry quoting De Morgan says:[99]

> What appears at a very early date in Egypt is perfection of technique. The Egyptian appears from the time of the earliest Pharaohs as a patient, careful workman, his mind like his hand possessing an incomparable precision ... a mastery that has never been surpassed in any country.

A carved (or ground?) diorite head from Egypt was sold in London some years ago for the sum of $50,000, and it was considered by the experts at the time "never to have been surpassed in the entire history of sculpture."[100]

It is hard to decide which of these two civilizations produced the most remarkable metal wares. The jewelled weapons of their noble dead are simply beautiful and have to be seen to be appreciated. There are no essential metallurgical techniques which they had not mastered very early in their history. These include filigree, mold and hollow casting, intaglio, wire-drawing, beading, granulation (in water?), welding, inlaying of one metal with another, sheeting hammered so thin as to be almost translucent, repoussé, gilding on wood and other materials, possibly spinning of metal, and later – even electroplating using a form of galvanic cell catalyzed with fruit juices and housed in a small earthenware jar.[101] One of these is illustrated in Fig. 15 (page 90).

Egyptian medicine will be treated in a later chapter since both it and mathematics are areas of human endeavour in which these ancient people achieved much, yet were clearly prevented from achieving more by reason of a certain attitude of mind which seems to have been responsible for their failure to develop the the scientific method.

This failure had a fatal consequence. The high technical competence in so many fields which they developed rapidly and exploited to our continuing wonderment, halted at a certain point, maintained itself for a few centuries unchanged, began to decay rather suddenly, and finally passed out of memory altogether until it was recovered from the dust of the centuries by the labours of archaeologists during the past century or so.

Sir Arthur Evan's[102] researches in Crete have revealed the same pattern of history. The magnificent Palace of Minos with its system of hot and cold running water, its rooms often decorated with a kind of wallpaper effect done (as is done today) with a sponge,[103]

its extraordinary architecture, its beautiful pottery – in many cases patterned upon metal prototypes, its highly organized court life, and its evidence of extensive trade and commerce overseas – all these achievements demonstrate clearly that the craftsmen of the ancient Minoan Empire were in no way behind the Egyptian and Sumerian in technical competence. Two sections of their water piping illustrated in Fig.16 (page 86). Like the drainage and sewage systems of the Indus Valley cities of Mohenjo Daru and Changu Daru, they are equal in effectiveness to anything we can install today. The underground sewage disposal system illustrated in Fig.17 (page 87), from Northern Syria, is clear evidence of a highly organized city life that presupposes the same kind of technical achievement and awareness of the possibilities of community responsibility. Indeed according to T.J. Meek, the people of Tell Halaf in Syria were never without metals, and their finely fired pottery "no thicker than two playing card" and beautifully designed, is equal to the best that the Sumerians produced.[104] It is closely paralleled by some of the earliest pottery found at Susa by De Morgan,[105] a city which was closely tied in with the Sumero-Egyptian Indus-Valley "Archaic Civilization" as W. J. Perry aptly called it.

Here, in these areas, lie the roots of all Western Civilization in its earlier stages of development. From these centres, sometimes directly, sometimes indirectly (as via the Etruscans) Europe derived the inspiration of its culture.

The indebtedness of the Greeks to the Minoans is now fully appreciated.[106] The Minoans had in turn derived much of their culture from the Egyptians. Some influences reached Greece directly from Asia Minor. Between these three sources can be divided

almost everything in Greek culture that has a technical connotation: mathematics, architecture, metallurgy, medicine, games, and even the inspiration of much of their art – all was borrowed from such non-Indo-European sources. Even their script was borrowed. In fact one might say their very literacy, for influential figures like Socrates, far from contributing anything to the art of writing, actually strongly opposed it as a threat to the powers of memory.

The same is true of Rome. The part played by the Etruscans in the foundation of Roman Civilization is immense. Sir Gavin De Beer in a recent broadcast in England said:[107]

> It may seem remote to us [to ask who the Etruscans were] and yet it affects us closely for the following reason. We regard the Romans as our civilizers, and we look up to them as the inventors of all sorts of things they taught us. But it is now clear that, in their turn, the Romans learned many of these from the Etruscans.

De Beer holds that whatever else might be said about these interesting people, their language at least was non-Indo-European, and they were not related either to the Romans or the Greeks. With this, agrees M. Pallottino, an authority on the Etruscans.[108] George Rawlinson, the great Orientalist and classical scholar says in this respect:[109]

> The Romans themselves notwithstanding their intense national vanity acknowledged this debt to some extent and admitted that they derived from the Etruscans their augury, their religious ritual, their robes and other insignia of office, their games and shows, their earliest architecture, their calendar, their weights and measures, their land surveying systems, and various other elements of their civilization. But there is reason to believe that their acknowledgement fell short of their actual obligations and that Etruria was really the source of their whole early civilization.

To this list D. Randall MacIver adds their martial organization – and even the name of the city itself in all probability![110]

Out of Africa has come to us far more than just the Egyptian contribution even were this not a sufficient one. One does not think of Africa as particularly inventive. As a matter of fact, however, so many new things came from that great continent during Roman times that they had a proverb, "Ex Africa semper aliquid," which freely translated means 'There is always something new coming out of Africa.'[111] Among other things there came out of Africa "Animal Tales" from Ethiopia. Edwin W. Smith and Andrew M. Dale point out in this connection:[112]

> It might indeed be claimed that Africa was the home of animal tales. Was not the greatest "literary inventor" of all, an African, the famous Lokman, whom the Greeks not knowing his real name called Aethiops (i.e., Aesop)?

Even in medicine Africans have some remarkable achievements to their credit. To mention but two: the Pygmies of the Ituri Forest had invented an enema quite independently of its South American Indian counterpart,[113] and it is known that Caesarean operations were successfully undertaken in childbirth emergencies before the White Man had succeeded in doing it.[114] Out of Ethiopia came also coffee.[115] And quite recently African art has been the 'inspiration' (for good or ill is a matter of taste) of new forms of art. Very recently a kind of rocking stool, inspired by an ingenious African prototype, has come into popularity.

Their engineering skill is often revealed in very simple things. A carrying chair, illustrated in Fig.18 (page 88) is so designed that the rider receives the absolute minimum of jolts and rockings due to the unevenness of the ground. It is a kind of super-whiffle-tree sling that equalizes the load and guarantees smooth passage. It is simple and effective and designed on entirely sound engineering principles of which the makers were probably hardly aware.

As a further witness to the same kind of genius for simplified construction an African loom is shown in Fig.19 (page 89). It makes the most effective use possible of locally available raw materials, and in fact uses their actual form to the best advantage.

Almost every African community of any size has its own smelting furnace and smithy. No part of this iron working art has been borrowed from Europe. The whole process (and the refinements found in some cases) is a native invention. The bellows used to increase the oxygen supply and thereby the heat at the hearth, are of native design and manufacture and are very varied in form. The pipes which convey the air into the furnace are also home made. Suitable clay is plastered around pieces of wood of the proper size and shape (whether curved, straight, or even forked), and then the whole is burned in a fairly hot fire. This reduces the wooden insert to ashes and leaves the desired pipe form, shaped and baked all ready for use. When the ore has been reduced and the metal is removed from the dismantled furnace it is worked by hand. The metal may be hammered into sheet, drawn into wire, or forged into other forms such as vessels, blades, etc., as desired. It is not surprising that we, having largely learned from Africa the basic techniques of

iron-working, should refer to our iron metalworkers as Blacksmiths. R. J. Forbes says that although today African smiths often obtain their raw materials from European sources, the Negro smiths "are very ingenious craftsmen in inventing and using new tools and types of bellows."[116]

Samuel N. Kramer[117] has recently published a volume resulting from a lifetime of cuneiform studies which he titles *From the Tablets of Sumer*, and his subtitle takes the following form: "*Twenty-five Firsts of Man's Recorded History.*" It is an impressive collection of "firsts," yet one will feel at times that he has introduced a few cases which are only rightly termed so, by a kind of special pleading. But on the whole his collection shows that their inventiveness was by no means limited to mechanical things, but applies equally well to certain forms of literature – and indeed to the very idea of collecting libraries, writing histories, and cataloguing books for reference.

Among the literary achievements of the Egyptians are to be listed what was surely the first 'moving-picture' sequence,[118] and the first Walt Disney Cartoon.[119] Gloves and camp stools are found first in Crete,[120] soap in Egypt,[121] virtually all carpenter's tools (saws, squares, bucksaws, brace and bit, etc.) from the Etruscans[122] – with a novel brace and bit,[123] and the 'level' from Egypt.[124] The Etruscans invented lathes.[125] The Egyptians built a pipe-organ using water to obtain a uniform air pressure apparently.[126] Folding umbrellas and sun-shades were first designed in China[127] and were not introduced into England until centuries later where the introducer apparently almost lost his life! The Sumerians used

straws for drinking with,[128] (see Sumerian 'straws' shown in Fig 20 page 00) and bequeathed to their successors chariot wheels which were made of plywood using exactly the same technique for the manufacture of it as we use today.[129] Africans were using vaccines long before the White Man adopted the measure:[130] and there is a record of the invention of a malleable glass, the secret of which was destroyed by the ruling monarch, along with its originator, for fear of upsetting the economy.[131] Every form of building technique now commonly used (including concrete) is found among non-Indo-Europeans, and in many cases long antedating the Romans, especially the arch, barrel vault, dome and cantilever principle of construction. The barrel vault was achieved in Babylon without the need of a supporting scaffold under it, by starting against an upright wall, which was later removed. The cantilever principle was used by the Egyptians (among others) in strengthening their larger seagoing vessels to prevent them from 'breaking their backs,' as marine engineers term it. One such vessel is shown in Fig.21 (page 91).

Speaking of boats, James Hornell, an authority on water craft as developed by primitive and ancient people, opens a paper on the subject with these words:[132]

> There can be no doubt that to Asiatic ingenuity we owe the beginnings of the world's principle types of Water Transport. Early man in Asia invented means of extraordinary diversity to enable him to cross rivers, etc. ...

If we bear in mind that China gave us the stern-post rudder, and watertight compartment construction, as well as canal locks for inland waterways,[133] and that the Koreans built the first true battleship, with iron cladding – notwithstanding the claims

made for 'Old Ironsides' in Boston Harbour, it will be seen that we have not contributed a great deal basically to marine engineering. Isabella L. Bishop says of this Korean warship, that it was named Tortoise Boat, and was "invented by Yi Soon Sin in the 16th century, enabling the Koreans to conquer the great Japanese General Hideyoshi in Chinhai Bay."[134]

Naphtha gas was first used by the Sumerians,[135] eye salves in multiple tubes probably by the same people,[136] and spray-painting by palaeolithic man![137] Cigarettes were known to the North American Indians long before Europeans had even heard of tobacco:[138] spectacles are probably a Chinese invention:[139] and safety pins came from the Etruscans.[140] The Chinese did many things with glass, for according to Bruno Schweig there is evidence of glass mirrors as early as 2000 B.C.:[141] and although the source of my information here is not the best, there is a reference to the first 'windows' of glass in a collection of Chinese Stories. It is said that in the reign of Emperor Ming, a man named Wing Dow invented a 'device' which he called Looking through-the-Walls, whence it is claimed we now derive our word Window, being a corruption of the inventor's name.[142]

Although the abacus seems a very slow and primitive way of making calculations, recent experiments undertaken by experts in both the ancient instrument and the modern electrically operated comptometer, have shown that in the hands of a skilled operator it can hold its own against all mechanical devices (excluding computers), except in one particular type of calculation.[143]

Comte Du Nouy, after a backward look at the 'rostrum of ingenuity' which meets the eye from antiquity, expresses the conviction that:[144]

> Intelligence does not seem to have increased radically in depth during the last 10,000 years. As much intelligence was needed to invent the bow and arrow, when starting from nothing, as to invent the machine gun, with the help of all anterior inventions.

The point is well taken, and one demonstration of the wisdom of this observation is that the experts find it quite impossible to determine now, how the first bow ever came to be invented. Their reconstructions are as varied as can be: which tends to show that such a weapon would certainty not, as it were, occur easily to its originator if we cannot even imagine how it originated with one right in front of us.

Finally, we come to the great contribution made by China. If we should ask today what three things above all have contributed to or are contributing to our present conquest of the earth, we might possibly agree that printed matter, a convenient medium of exchange of some kind (i.e., paper currency), and powered propulsion are fundamental. All of these – and of course hundreds besides – we have derived from China, though often indirectly via the Arab world.

For our wheeled vehicles we initially used draft animals domesticated in the Middle East, but because of harnessing methods, these draft animals could not pull nearly as much as they now do, thanks to the development in China of far more effective systems of harness. But we have of course long since passed out of the draft-horse age into the

jet propulsion era. The motive power for such high-speed engines was likewise inspired by the Chinese. In the air, China and the Far East anticipated us in virtually every form of airborne vehicle or device, including of course rockets, but also kites, gliders, balloons, parachutes, weather forecasting, and even the helicopter principle in the form of toys. Because of the extraordinary developments of Chinese technologists, it is not uncommon to see references to their "science." As we shall try to show this is perhaps an error, even though some of the greatest authorities do it. In reviewing Needham's *magnum opus* on the *Science and Civilization of China*, the Editor of *Discovery* says:[145]

> We are forced to realize that the old question as to why Science failed to develop in China must be replaced by the much more cautious one, "Since the Chinese people have shown ability to observe and invent surpassing that of the West until comparatively recent times, what factors in environment and thought carried them so far and yet prevented the development of the full scientific method?"

With all due respect to both Needham and the Editor of *Discovery*, I think there is a serious danger here of supposing that Science is merely an extention of Technology, a kind of natural adult stage. I would rather take the view held by James Conant that Science is not merely an extension of Technology, any more than infinity is merely a very very large number; it is in a different category. One should not speak of a 'full scientific method,' any more than one should strictly speak, conversely, of something only being 'half-alive.'

But of their engineering achievements and mechanical and technical skill there is not the slightest doubt. It is all the more remarkable that they did not step over the boundary

into the kind of Industrial Revolution which resulted from the development of Science in Europe. Certainly there is no evidence that either they, or any of the other highly developed civilizations we have been discussing, were ever on the verge of doing so. As Herbert Butterfield put it in his Origins of Modern Science:[146]

> There does not seem to be any sign that the ancient world before its heritage had been dispersed was moving towards anything like a scientific revolution.

The question of why China stopped short where she did, is explored at great length by Needham: his knowledge of Chinese culture should surely entitle him to speak of their having achieved a measure of scientific knowledge, if he feels it is justified to do so. And this he does. To challenge such an authority must appear as little more than impudence on the part of anyone whose knowledge is so completely derived from secondary sources. Yet even Needham himself makes admissions now and then which are tantamount to saying that he is using the word Science to mean merely a highly developed Technology, and nothing more. The Chinese, as he makes quite clear, were never impractical dreamers or people likely to waste time asking questions whose answers did not seem to be of immediate practical value. Yet this is an essential attitude for the scientific mind.

In reviewing Needham's work, Robert Multhauf indicates that the conclusion to be drawn from the two volumes published thus far, is that Chinese Technology participated little and probably contributed little immediately to the development of scientific thought.[147] In fact, Needham himself asserts that the Chinese worldview depended on a totally different kind of thought pattern from that in the West. What he could have

mentioned, perhaps, is that it is not only unlike that of Western Man, but it is exceedingly like that developed by almost all other cultures which are non-Indo-European. In a subsequent chapter this will be considered carefully. It is of fundamental importance and to my mind accounts for the absence of Science not only in China but in all other cases. It is interesting to find that a Chinese man writing a few years ago on this very point, titled his Paper, "Why China has no Science." In this, the author, Tu-Lan Fung, makes it clear that a feeling for the essential personal-ness of Nature is what discouraged experiment:[148] plus a conviction that the definition of what is 'righteous' is what is 'useful' in the immediate sense – leading to considerable distrust of activities of a purely intellectual or abstract character, and a feeling of positive distaste for experimenting with Nature. Scientific research, in the proper sense, was an im-pure waste of time that almost amounted to sacrilege! As he put it, "to speak of things in abstract and general terms is always dangerous."

But meanwhile in this chapter, we shall review briefly their Technology. That we obtained from China – silk, porcelain, explosives, paper, printing with moveable type, paper money, the magnetic compass, and mechanical water clocks is so well known that the facts need little or no elaboration. That they anticipated us in the use of gas for cooking and heating, cast iron, flame weapons in warfare, and, as has been stated above, the initial conquest of the air is possibly less well known. In addition to this they initiated the use of fingerprinting for identification purposes, chain pumps, the crossbow and a repeating bow with 12 shots per loading, gimbal suspension systems, the draw loom, the

rotary fan and a winnowing machine, piston bellows, wheelbarrows, stirrups, a greatly improved harness for draft animals that enabled them to pull almost twice as heavy a load, deep drilling methods, and much more is even less commonly known.

Marco Polo gives us an extensive account of the use of paper money.[149] He say it was issued in various denominations, stamped authoritatively by the Governor of the mint, and circulated as the only form of valid currency over a very wide geographical area. The bills, he says, were quite remarkably strong and did not tear easily: any which had been torn, however, or had suffered defacement, were recalled to the mint and replaced. Strikingly reflecting our own bills of a few years ago, they contained a promise that they would be redeemed for certain fixed quantities of either precious stones or precious metals upon request! Foreign merchants could not sell their jewels or precious metals on the open market, but were required to turn them in at the Mint, where they received a good recompense in paper money.

Consider how great such an innovation really was. As Marco Polo says, a man who wished to move could turn in hundreds of pounds (by weight) of valuable goods in personal property, and walk away with a pocketful of money so light as to be hardly noticeable with which in some other part of the Empire he could recover his hundreds of pounds of goods. Everywhere else in the world men were loaded down with the weight of their possessions which often took such a form as to be virtually worthless once the owner left his own locality. What such a scheme did for trade and commerce is incalcuable. What paper money does for us today whether in notes or cheques, is virtually

to keep our civilization running. Maybe, we would have come to it anyway in time. Certainly we did not initiate the idea. It originated in the 13th century with the Great Khan.

It was, as Needham points out, often many centuries before such inventions reached the West from China. And he also notes that China received from the West very little in return: actually, only four items are listed – the screw principle, a force pump for liquids, the crankshaft, and clockwork powered by a spring.[150] Of these in turn, only the screw principle and an alternative form of it (the windmill) seem actually to be to the credit of Indo-Europeans, possibly the Greeks for the screw and the Persians for the windmill. There is evidence that even the screw was obtained from Egypt. Needham points out that the art of drilling deep wells or bore-holes as used today in exploiting oil reserves is specifically of Chinese origin.[151] He also mentions that the use of graticules on maps to simplify the specifying and location of places, is probably of Chinese origin, although Ptolemy also employed this method.[152] For almost all Needham's illustrations, one thing can be said, to use his own words:[153]

> Firm evidence for their use in China antedates and sometimes long antedates, the best evidence for their appearance in any other part of the world....

He then quotes Toynbee as having said:

> However far it may or may not be possible to trace back our Western mechanical trend towards the origins of our Western history, there is no doubt that a mechanical penchant is as characteristic of the Western civilization as an aesthetic penchant was of the Hellenic ...

Of this observation, Needham says, "It is to be feared that all such valuations ... are built on insecure foundations." The fact is, we simply do not have any such penchant if we judge our 'racial' character by looking at our achievements prior to the time we began to borrow from non-Indo-Europeans. Since that time, racial mixture has taken place on such a scale, and with it of course 'cultural' mixture also, that it is difficult to say for certain who is and who is not Indo-European in many cases. About all we can do is to attempt to gain a certain measure of objectivity in this regard by looking more carefully at the actual achievement involved in many borrowed elements of our civilization which we now think simple and obvious, merely because we have become so used to them.

Take as an example, the preparation of silk. Sarton says of this:[154]

> Consider what the invention implied – the domestication of an insect, the 'education' of silkworms, the cultivation of the white mulberry, the whole of sericulture!

But – which is more – it involved the recognition of the possibilities of the material in the first place. Spider web is one of the strongest known natural filament, but it does not seem that anyone ever thought of cultivating spider web for this purpose. The idea of such a possibility is not enough. It requires considerable energy to turn it into a working industry, and although it seems highly improbable that it was done in a single step, somebody must have been alive to the practical advantages of making the effort – and have demonstrated it could be done. But then it seems, having developed the 'industry' until it was producing results, there it was left... with virtually no effort to extend it or improve the technique or seek for substitute insects or even attempt to make a synthetic

material using the same kind of substance produced by other means. This is the kind of thing we are good at: but we always seem to need the initial stimulation from somewhere else.

Needham also draws attention to the fact that the Chinese have excelled in the art of war, inventing new weapons and new methods of attack or defence. The repeating or 'magazine' crossbow, of which an example of the mechanism is to be found in the Royal Ontario Museum, is surely the world's first machine gun.[155] To their credit (?) must also be given the invention of flame weapons and smoke bombs. Although the former appeared in the Mediterranean area first from North Africa, being used there against the Romans, there is no doubt that the Arabs derived them from the Chinese, for they called them "Darts of China." In a classified document on Chemical Warfare published some years ago in the United States, Harold Lamb had this to say:[156]

> A search through Oriental annals reveals other ancestors of present European weapons. But it is a little surprising to find the modern hand grenade, flame-thrower, and cannon in use in Asia centuries ago.
>
> In Roman days vases filled with a fire compound were employed by the Persians at the Siege of Petra. This compound was sulphur, asphalt, and naphtha; and the vases were cast by mangonels (a kind of giant catapult). The flames which sprang up when the vessel broke could not be extinguished. This was the origin of the much talked about Greek fire, which they, having borrowed it from the Arabs ... were surprised to find would continue to burn on water, a fact which mystified the early Crusaders.

> Haram al-Raschid used a sulphur-naphtha compound at the siege of Heraclea.... At the siege of Acre, a Damascus engineer destroyed the wooden towers of the Crusaders by casting against them light clay vessels of the fluid until everything was well saturated. Then a flaming ball was thrown out and, as we read in one old Chronicle, "all was destroyed by flame, man, weapons, and all." During the 13th century flame weapons were highly developed by the Arabs. They had hand grenades – small glass or clay jars that ignited when they broke; and a curious fire-mace, that was to be broken over the head of a foe, its owner keeping well to windward!
>
> Flame throwers appeared in the form of portable tubes that could burn a man to ash at 30 feet [We still cannot do much better – or worse – with modern weapons! ACC]. Some of the names of these flame weapons, such as "The Chinese Flower" and so on, only indicate that they had their origin in that country. In fact we find the Chinese of the 13th century very familiar with destructive fire. They had the *pao* that belched flaming power, and the *fie-ho-tsing*, the "spear of fire that flies."

It seems then that the Arabs borrowed much from the Far East – paint brushes (but with the original pig bristles replaced by camel hair –for religious reasons), paper manufacture, block printing, silk, alchemy, and of course such weapons of war as the above in addition to explosives. They were great carriers but apparently somewhat uninventive except possibly during one short period of their history. Further reference to this point will be made in the next chapter.

Another document prepared by the Office of the Chief of the Chemical Warfare Service (Washington, 1939) opens with these words:[157]

> Ghengis Khan, famous ruler of the Mongols and of China, used chemicals in the form of huge balls of pitch and sulphur shot over the walls of besieged towns to produce a combination of screening smoke, choking sulphur fumes, and incendiary effects as a standard routine of attack.

Even 'irritating' gases were used by the Arabs against the Roman Legions in North Africa as early as 220 A.D. According to Captain A. Maude, the secret of this weapon

was learned by the Romans finally by the capture of a Prince of Mauritania named Juba II, subsequently married to Selene, the daughter of Cleopatra.[158]

The Chinese, curiously enough did not make much use of their explosives in warfare by developing cannon until the idea was suggested to them by Europeans! But they did make rocket arrows, and their launching devices were certainly the sires of modern multiple rocket launchers. Some illustrations of these, from a Chinese manuscript, are given in Fig.22 (page 92), and in Fig.23 (page 91) is a single rocket weapon that might well deter anyone! They also developed 'psychological' weapons using large arrows with whistling or 'screaming' heads on them that were guaranteed to stampede horses. Some of their bows were so beautifully designed that, as Klopsteg has shown, they could actually shoot up to half a mile with them.[159]

Their gunpowder burned rather slowly and unevenly. Hence it was not too effective in cannon. But this did not deter them. They made *use* of the fact. Practically speaking, they arranged the cannon's barrel so that it was free to move and then fastened the charge in it so that it stayed with the weapon, thus they had a jet propelled rocket. They then made the tube out of tightly wound paper to save weight, and put a point on it for better flight. But they soon found that because of the uneven burning of the propellant the rocket's flight was somewhat erratic. This they overcame by putting a trailing stick on it to steady it. At first this stick had feathers, but they found that the feathers were simply burned off. It made no difference, for these feathers proved unnecessary. What they did

discover was that regardless of the size of the rocket, it had the best balanced flight when the stock was seven times as long as the rocket head. This is still found to be so.[160]

Willey Ley says that the Arabs learned of these weapons from the Chinese and thus called them "Alsichem alkhatai" or Chinese Arrows.[161] The French Sinologist, Stanislas Julien, has found references to these rockets in China as early as 1232 A.D.

In metallurgy (and in alchemy), the Chinese were far ahead of the West very early in their history. R. J. Forbes, a foremost authority on metallurgy in antiquity, tells us that they were making cast iron stoves by 150 B.C. at least.[162] A picture of one such stove is given for interest's sake, though the original source of the illustration cannot be vouched for. It was used by the Borg-Warner Corporation in an advertisement in a Technical paper (Fig.24 page 93).

Another metallurgical journal gives a picture of a huge single cast iron statue which is believed to have been set up in 953 A.D. This is held to be one of the largest single iron castings ever made. It is shown in Fig.25 (page 94).

As a matter of interest, it is sometimes pointed out that the Hittites (possibly a non-Indo-European people with an Indo-European aristocracy) who disappeared from History so completely that their very existence was once doubted, are referred to in cuneiform documents as the Khittai, and sometimes as the Khattai. C. R. Conder suggested that they disappeared because when their Kingdom came to an end, the people packed up and travelled East where they left their name associated with China and the Far East in the form 'Cathay'.[163] The Arabs term Chinese Arrows as Alkhatai, as we have seen.

Forbes holds that the Hittites discovered cast iron even before the Chinese did. If this is true, it would suggest that this is possibly where the latter obtained their knowledge of it.

In the conquest of the air, China played a very prior part. Francis R. Miller states that:[164]

> China enters first claim to the invention of the balloon – centuries before Europe knew it. The Chinese further claim to have had a system of signals by which different toned trumpets sounded from the top of high hills and gave notice of impending changes of wind and weather, for use by navigators of dirigible balloons.

Miller gives an illustration from an official Chinese document of a large dirigible said to have been used at the coronation of the Emperor Fo-Kien, in 1306. It was large enough to carry 9 individual gondolas which were lowered to the ground with pulley systems. In another place Miller reports that:[165]

> A contemporary of Confucius (c. 550 B.C.) named Lu Pan, who was known as "the mechanician of Lu," is said to have made a glider in the form of a magpie from wood and bamboo which he caused to fly.

Miller also states that kites, as precursors of airplanes, first appeared in Chinese annals at a very early date. Chinese scholars who kept records frequently refer to them. The earliest kites were used for military signalling first recorded in warfare in the time of Han Sin, who died in 198 B.C., one of the Three Heroes who assisted in founding the Han Dynasty. General Han Sin, plotting to tunnel into Wei-yang palace, flew a kite to measure the distance to it.[166]

According to Needham:[167]

> De la Loubere saw the parachute used by acrobats in Siam around 1688, and his description was read a century later by Lenormand, who then made some successful experiments and introduced the device to Montgolfier. This is not to deny that the idea of the parachute had been proposed in Europe at the time of the Renaissance, but there are Asian references to it much earlier still.

The first suspension bridges with iron chains were constructed in China at least 10 centuries or more before they were known and built in Europe.[168]

The story of printing and of paper manufacture is so well known as to need little consideration here. It came to Europe first with the old camel silk trains as a finished product – its secret of manufacture jealously guarded. Not until an Arab armed victory over the Chinese armies near Samarkand in 751 A.D. did paper settle in the West as an industry, set up by captured Chinese paper makers. Its use soon spread all over Europe. The development of printing depended upon the manufacture of suitable ink. We have already mentioned the use of carbon black to strengthen rubber. This material was first made by the Chinese who prepared it by burning oil and allowing the flame to impinge on a small porcelain cone, from which the deposited carbon was removed at frequent intervals with a feather. The famous stick ink resulted from the compounding of this with a strong glue solution.[169]

R. H. Clapperton has shown that the recent researches of Sir Aurel Stein and Sven Hedin prove beyond doubt that the Chinese were not only the inventors of rag paper, raw fibre (mulberry bark and bamboo paper) and paper made of a combination of raw fibre and rags, but also the inventors of loading and coating paper![170] We formerly used a china-coated paper to obtain the best reproduction of photographs with a fine screen,

though this has now been replaced with less expensive and possibly more durable plastic coatings. But the idea originated with the Chinese.

A recent Chinese author, Li Ch'iao-p'ing points out that Chinese inventions opened up new fields of chemical manufacture in early times, but then remained stationary for centuries. One of their earlier contributions to medicine was the extraction of ephedrine from the herb Ephedra, a process credited to a very famous Emperor Shen Nung, who is supposed to have lived somewhere between 3000 and 2200 B.C.[171]

A two thousand year old rig for drilling salt wells was recently cited as a good model still for the modern cable rig of today's oil fields.[172]

Even in the design of clothing, they seemed to have a genius for hitting upon the best end-results, quite apart from the actual materials they developed. Thus it has been recently shown that the so-called 'Chinese sleeve' which permits each forearm to be inserted into the opposite sleeve, is more effective for keeping the hands warm in cold weather than either Arctic mittens, or a muff! Europeans adoped muffs and mittens – but having investigated the Chinese pattern thoroughly, it now appears to be equally if not more effective.[173]

Although the 'clockwork' motor principle was taken to the Chinese from the West, their water clocks long antedated the European systems of keeping accurate time, and were certainly more dependable, especially when mercury was used in place of water. The complexity of these water-clocks has only recently been recognized as a result of the finding of some ancient documents sufficiently explicit and detailed to enable Needham

and some associates to draw plans and diagrams of their operation. This was reported recently in the British Journal *Nature*.[174]

These devices were highly ingenious, involving gear trains of several kinds, the speed being very exactly regulated by a most dependable and clever use of water or mercury. Knowledge of these seems to have come into Europe possibly during the Crusades.

The clocks were connected with astronomical observations, in an endeavour to predict seasons, etc., more exactly. The interest was purely of a practical nature.

As we have already mentioned briefly, the Chinese had already discovered the uniqueness of finger prints, and quickly perceived how useful this could be for identification purposes. They were used during the T'ang dynasty as early as 618 A.D.[175] According to a special report on the uses of natural gas, it is said that the Chinese were the first to use it.[176] Probably the Sumerians can dispute this claim. But the story goes that some villagers near Peiping were trying to put out a local brush fire, when they found one flame that could not be extinguished with water. "The practical villagers then built a bamboo pipeline, from the outlet to the village, and used the gas for heating brine to make salt." This is said to have taken place somewhere about 450 B.C. Whether they can be said to have 'invented' the use of natural gas or not is a questionable point – but certainly they were very quick to see its practical possibilities. This is in exact contrast to the Romans who produced Cast Iron in considerable quantities but threw it all away because they did not recognize it as a potentially useful product.[177] As we have already remarked,

the basic technology of all metallurgy is entirely non-Indo-European, even heat-treatment and casehardening being known before we 'discovered' it.

Indeed, in some instances, we not only never have improved upon the products of our instructors, but actually have not even been able to improve upon their methods of manufacture, where we usually shine. *Cire perdu* casting is still employed for small bronze statues of racing horses and such items, and even the use of cow manure for the mold has been retained from the most ancient times, to give the best results. This system is extraordinarily effective for casting hollow articles of intricate form, where the use of ordinary cores is quite impossible, and yet it is found in every primitive society that has any knowledge of metals, in every archaeological site bearing the remains of cultures who had developed metal casting skills, and virtually every high civilization with the exception of Indo-Europeans seem to have had knowledge of the art... almost exactly as it is done in Europe today. We therefore use the same basic methods as non-Indo-Europeans for casting hollow objects in metal as they used, just as we have adopted exactly the same method of moulding hollow objects in rubber (cored or slush-moulded) as the natives of Central and South America did.

Certain other contributions to our technology, notably in connection with the use of electricity and internal combustion engines, will be acknowledged in chapter three. They will be used to illustrate some important aspects of this question as to whose contribution has been most important.

Although it will be possible to quote authorities who do not hesitate to say in so many words that we have invented virtually nothing, such sweeping generalizations need qualification. In the first place racial mixture has proceeded so extensively in Europe and America that it is no longer possible in many cases to say, for certain, which individuals do or do not carry some non-Indo-European genes. In other words is no longer always clear who is truly Indo-European and who is not. But it is true to say that whatever inventiveness we have shown in the past three or four centuries has almost always resulted from stimulation from non-Indo-Europeans. Our chief glory has been the ability to improve upon and perfect the inventions of others, often to such an extent that they appear to be original developments in their own right. We can also make some claim to have greatly advanced mass production methods. But it would surely be a great mistake to credit the improver with greater inventive ability than the originator. Moreover, the individual who tells the truth 99% of the time, but now and then tells lies, would hardly be termed a liar. By the same token, it does not seem proper to call a people 'inventive' who once in a while do invent something, but who 99% of the time merely adapt the inventions of others to new ends.

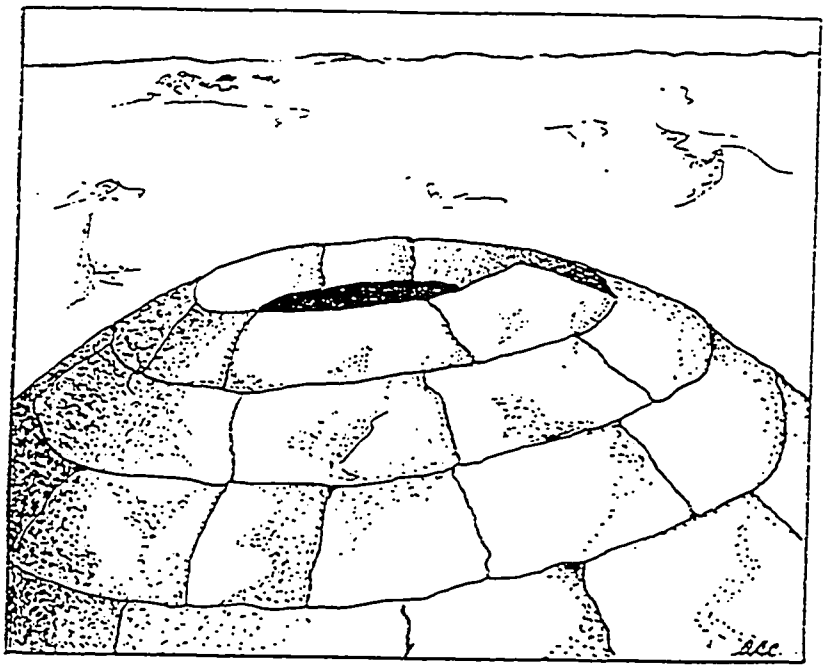
Paul Herrmann has written an interpretative survey of man's conquest of the earth's surface from Palaeolithic times to the present day. It is the work of one man, no small undertaking, and has therefore not the comprehensiveness one might desire, but it has the advantage of being a unified treatment. In his foreword he has this to say:[178]

> A further aim in writing this book was to weaken the very widespread conviction that our progress in the technological aspects of civilization represents, in any real sense, a greater achievement than that of our forebears. The liberation of atomic energy probably means no less than did the invention of the firedrill or the wheel in their day. Both discoveries were of immense importance to early man.

Needham says that the only Persian invention of first rank was the windmill, and apart from the rotary quern whose history is not quite certain, the only European contribution of value mechanically speaking, is the pot-chain pump.[179] This gives us two claims to originality. Compared with the originality of other cultures prior, let us say, to the 15th century A.D., we certainly did not shine in this direction. Yet we have advanced technology so far ahead of all previous civilizations that there must be some more subtle reason which will bear investigation.

It could be argued that primitive people do not invent much either: but this is easily accounted for. They do not see any need to do so. When that need arises, they are ingenious enough, though for reasons we may consider subsequently, they actually resist innovations as a rule.

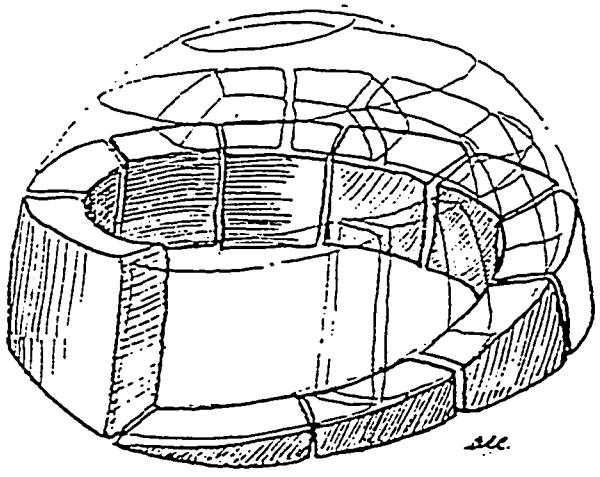
The next chapter will be devoted to an examination of two things. First, the evidence for this lack of originality among Indo-Europeans: and secondly, the evidence for the almost total lack among non-Indo-Europeans of that "impulse towards philosophical speculation" as Maritain so aptly put it,[180] which has finally given us the great technical superiority we currently enjoy over other cultures.



This drawing is from a photograph of an Igloo at Baker Lake, taken by Mr. Lloyd Wilson of the Defence Research Board. The original structure measured 17 feet in diam.

Figure 1.

A schematic drawing to show how the spiral construction is initiated.



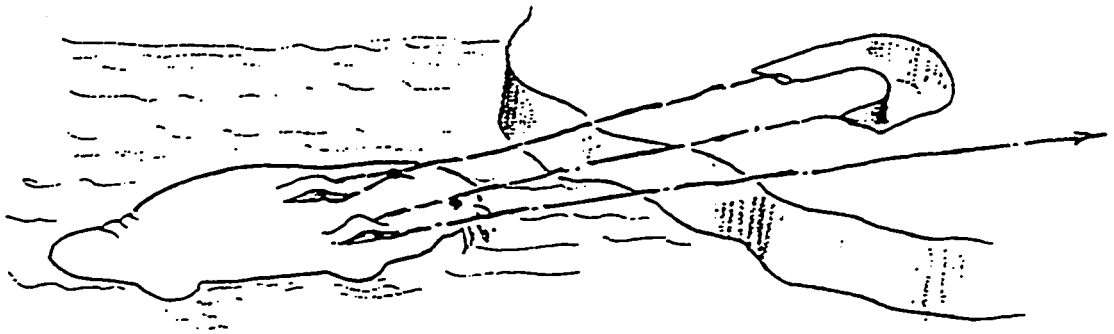


Figure 2.

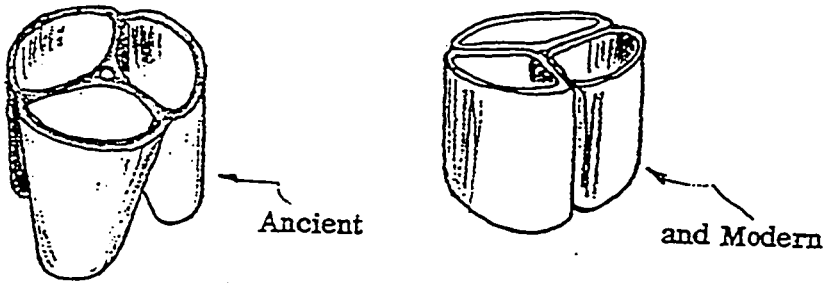
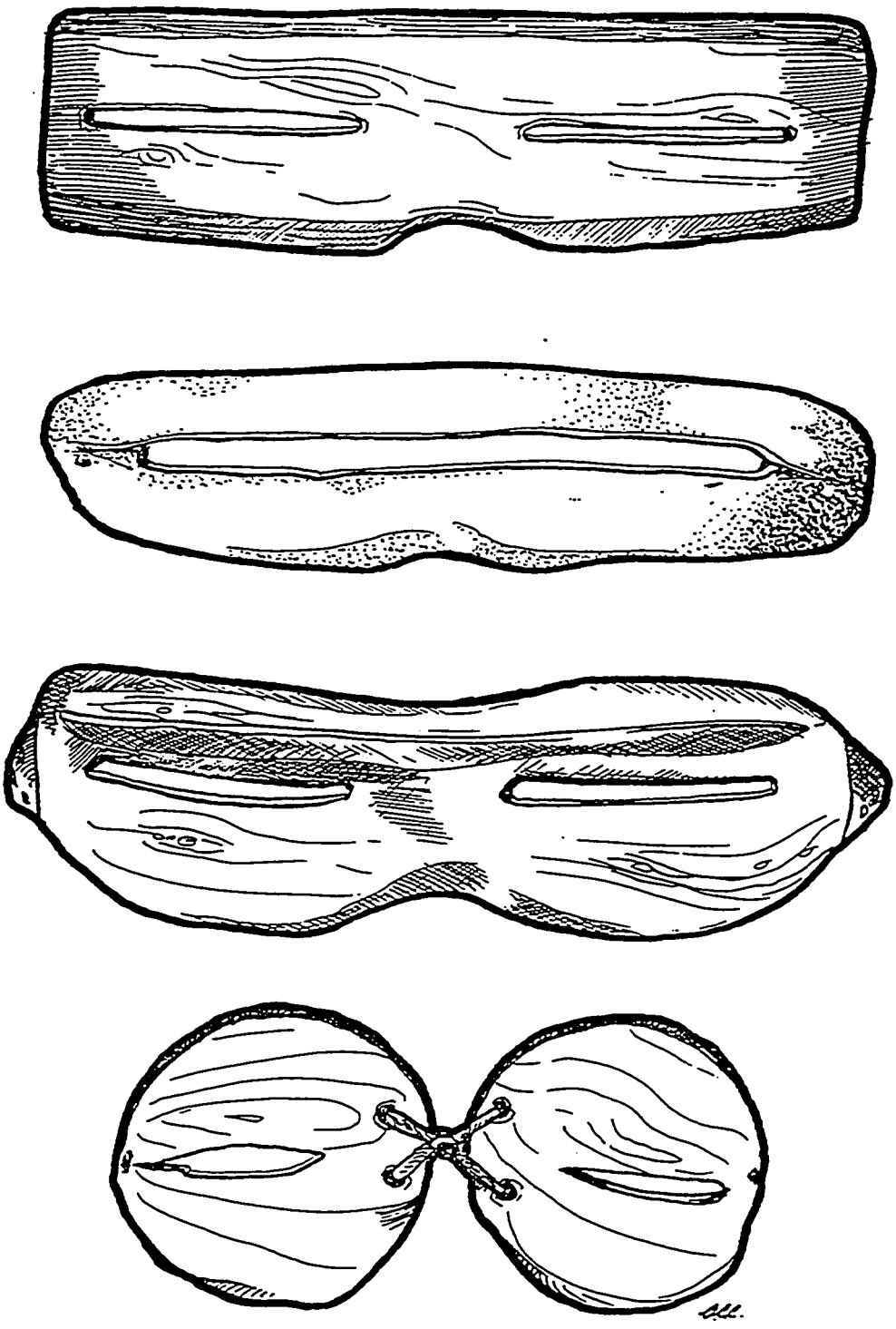


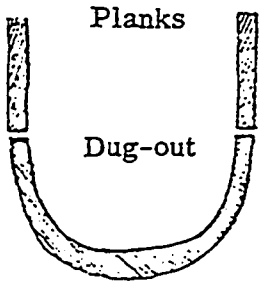
Figure 5.



Some types of wood and bone Eskimo Snow-goggles.

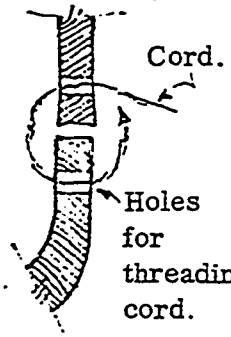
Figure 3.

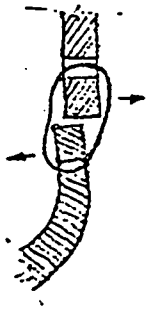
Polynesian Plank Canoes.



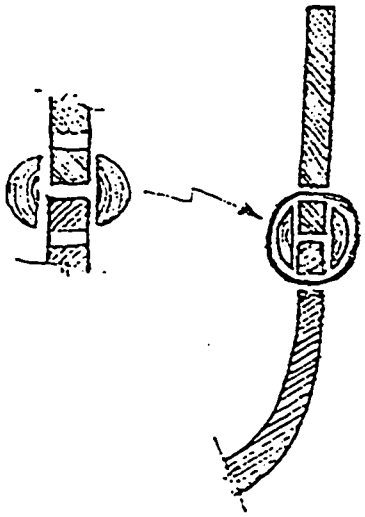
General arrangement, showing the two side planks, and the dug-out base to which they are fitted to raise the wall height.

Plank and dug-out simply lashed together





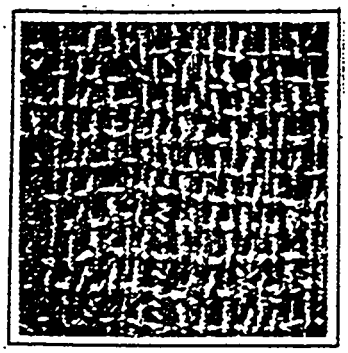
The plank can be slid to one side thus loosening the caulking.



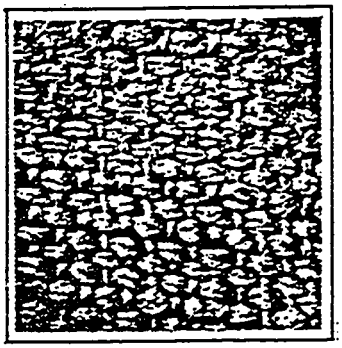
In this set-up, a piece of half-round material is fitted under the lashing on each side, thus holding the planks and the dug-out section firmly in line with one another, preventing the loss of caulking.

Anyone who will try this experiment for themselves will find that it is impossible to secure two pieces of planking together securely so that they will not move out of line. This method is completely effective.

Figure 4.

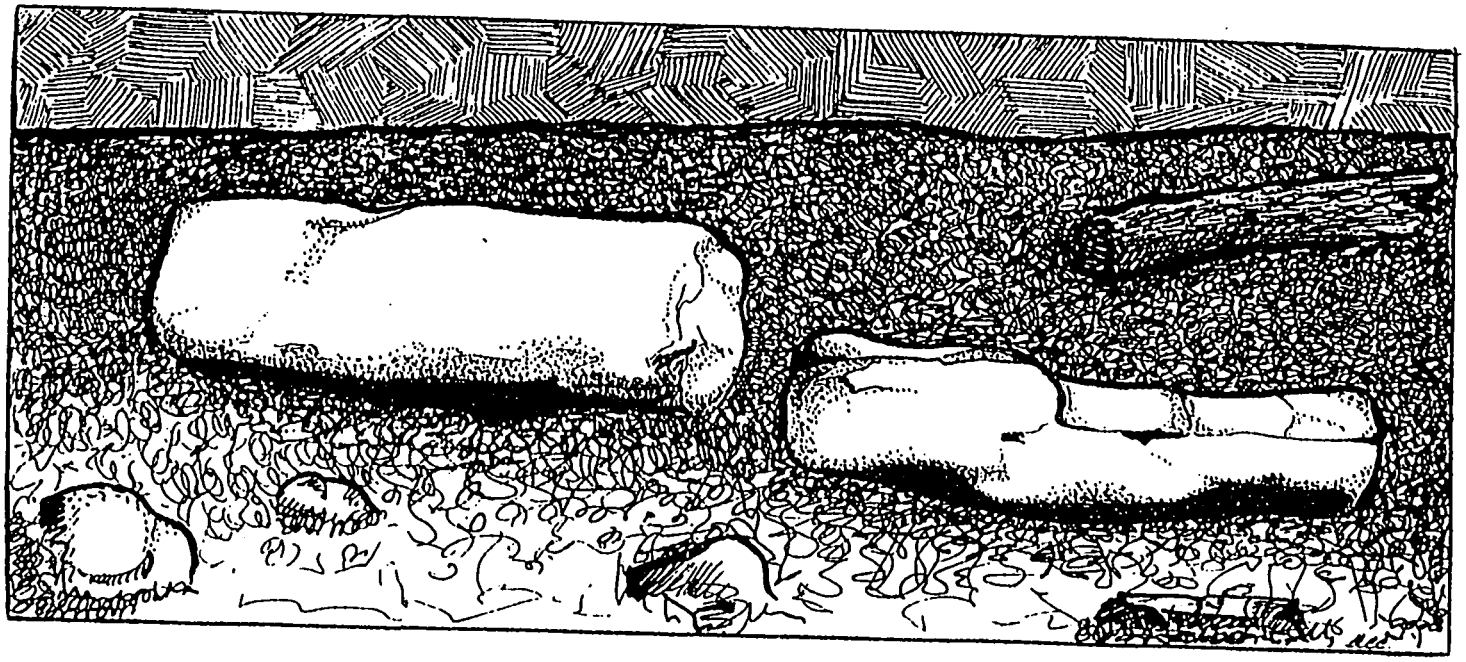


These samples of fabrics were taken from Tutankhamen's tomb. They are three different pieces of material, (a) being a dark cream colour with a light filmy texture, (b) a dark brown, almost black, with two threads one way, and one the other way, and (c) is a dark brown of coarser weave.



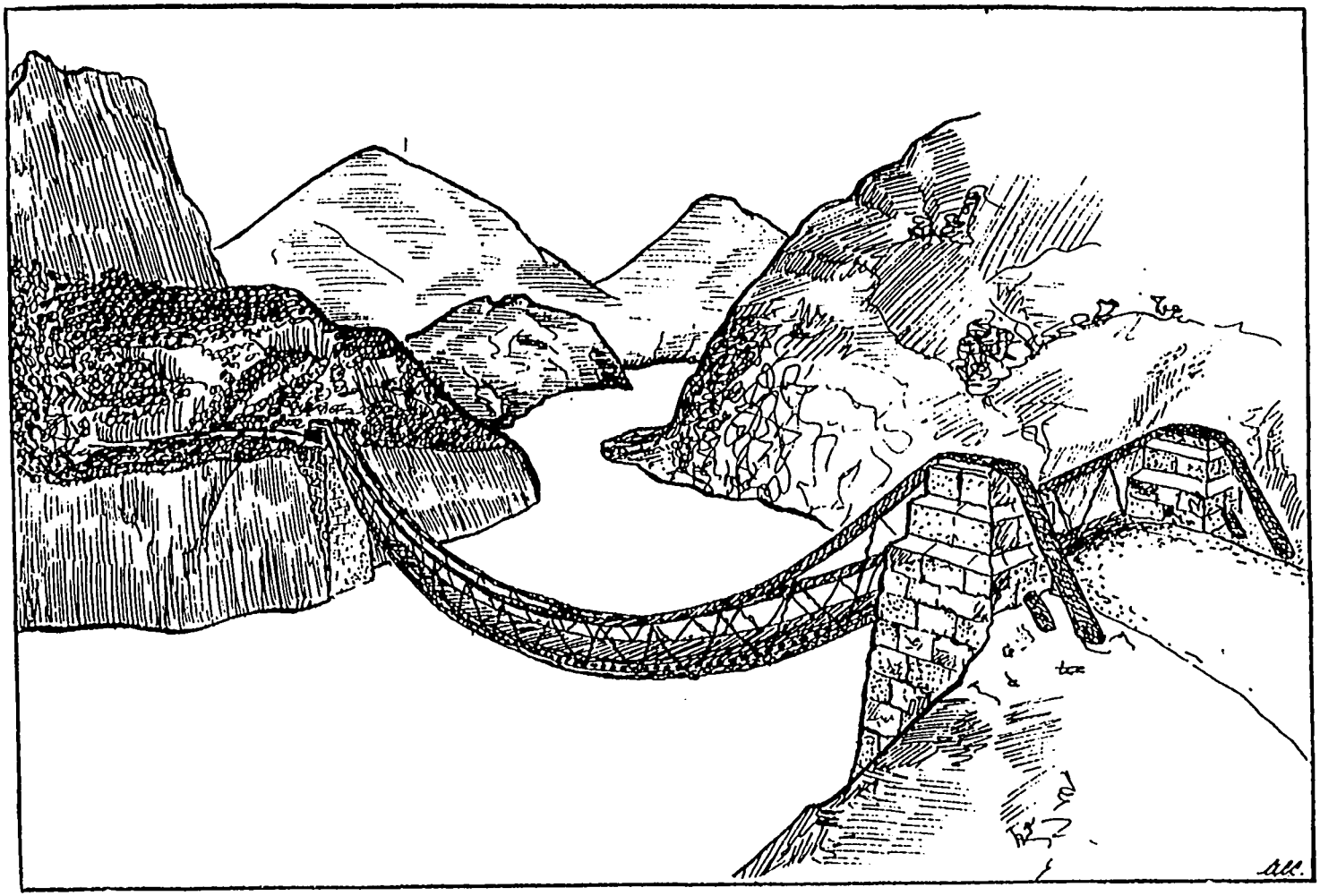
These photographs were taken with a microscope, thus emphasising the size of thread and concealing the fine texture of the cloth. Magnification was 15 x. Sample (a) reveals about 220 threads to the inch.

Figure 7.



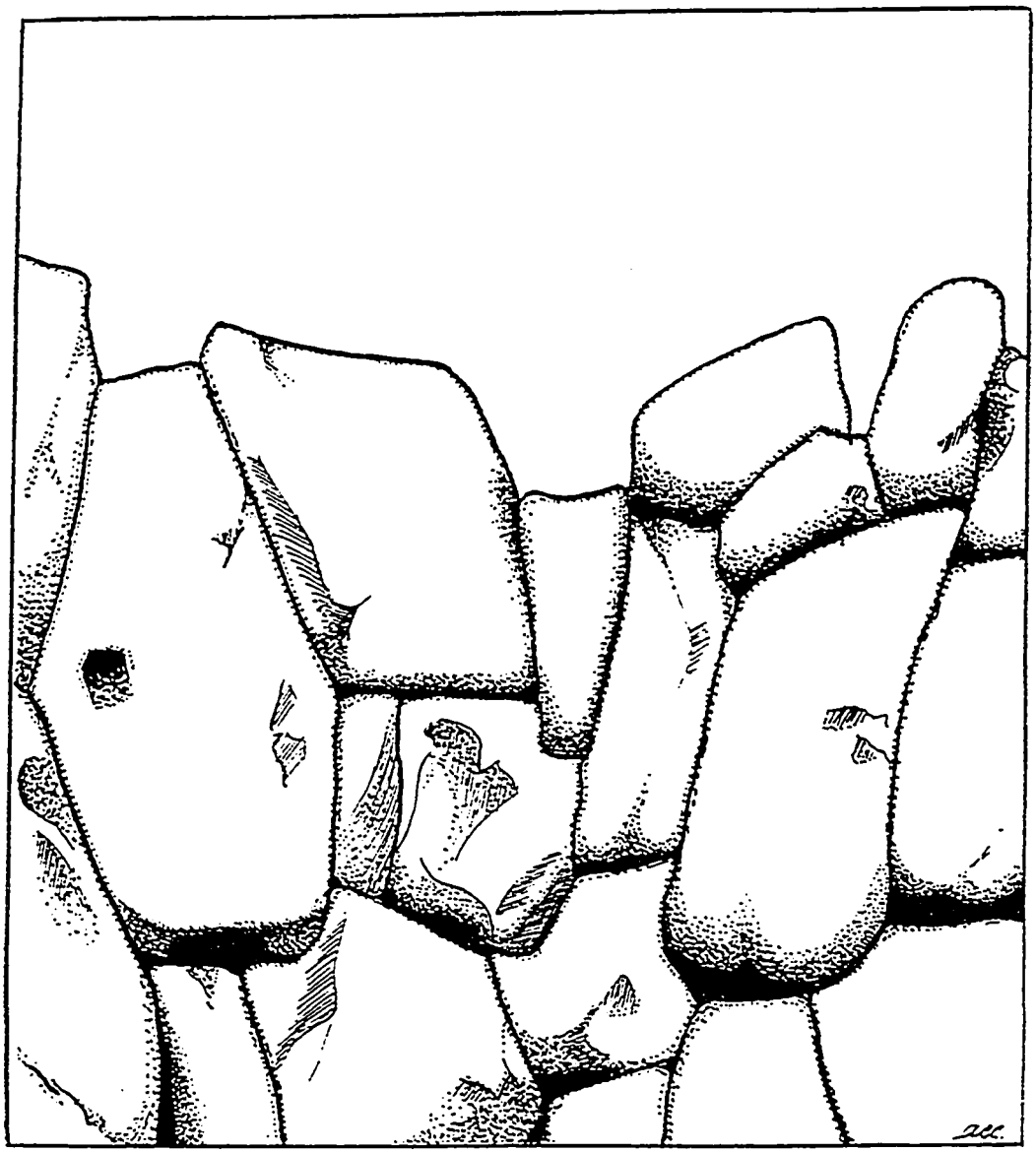
A drawing from a photograph of a broken 'road roller' or of two smaller ones, found about 22 miles out of Juxuna on the ancient Maya Causeway leading to Coba, in Yucatan.

Figure 8.



Inca Suspension Bridge, over the Rio Pampas, redrawn from an original sketch by E. George Squier, 1877.

Figure 9.



Part of the Fortress Wall,
Sacsahuaman, near Cuzco.

Figure 10.

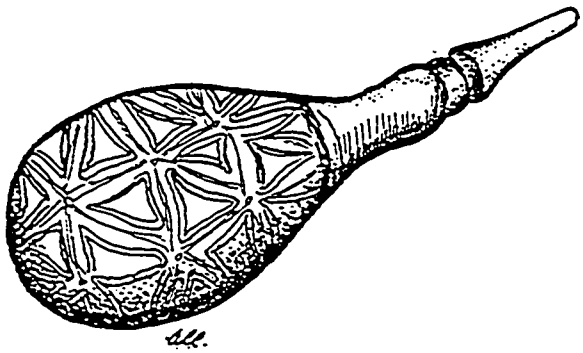
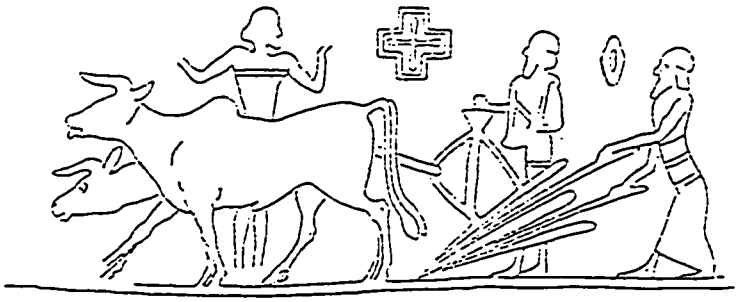


Fig.6.

A rubber bulbed enema syringe from the Omagua Indians of Guiana and the Upper Amazon River Region.



This seal impression is identified by Prof. A. Clay as UPMP II 66, Univ. of Penn. Museum Publications. It is interpreted by him as a Plow. That it is in reality a mechanical seeder seems clear from the hopper, and the three 'drills'.

Figure 12.

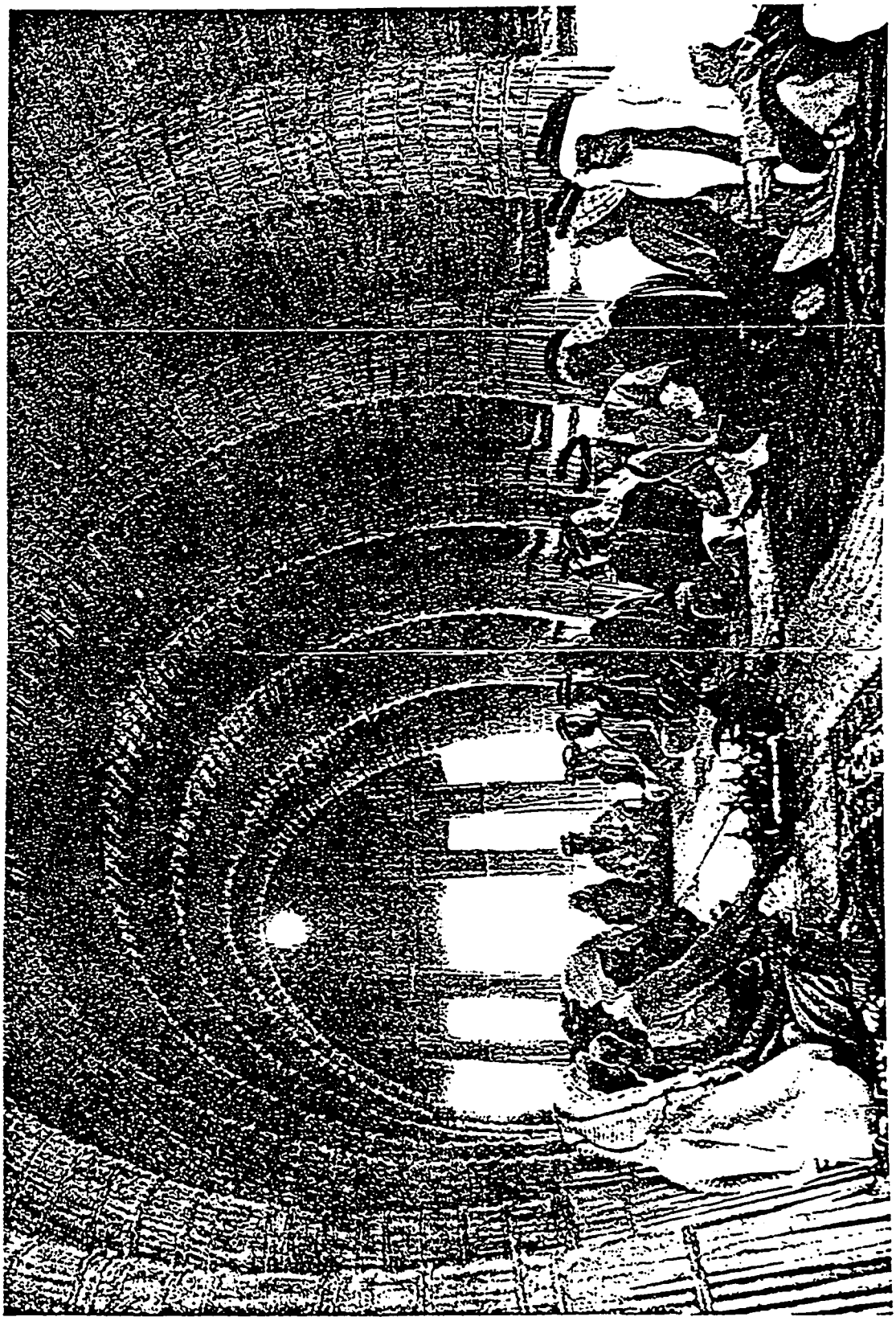
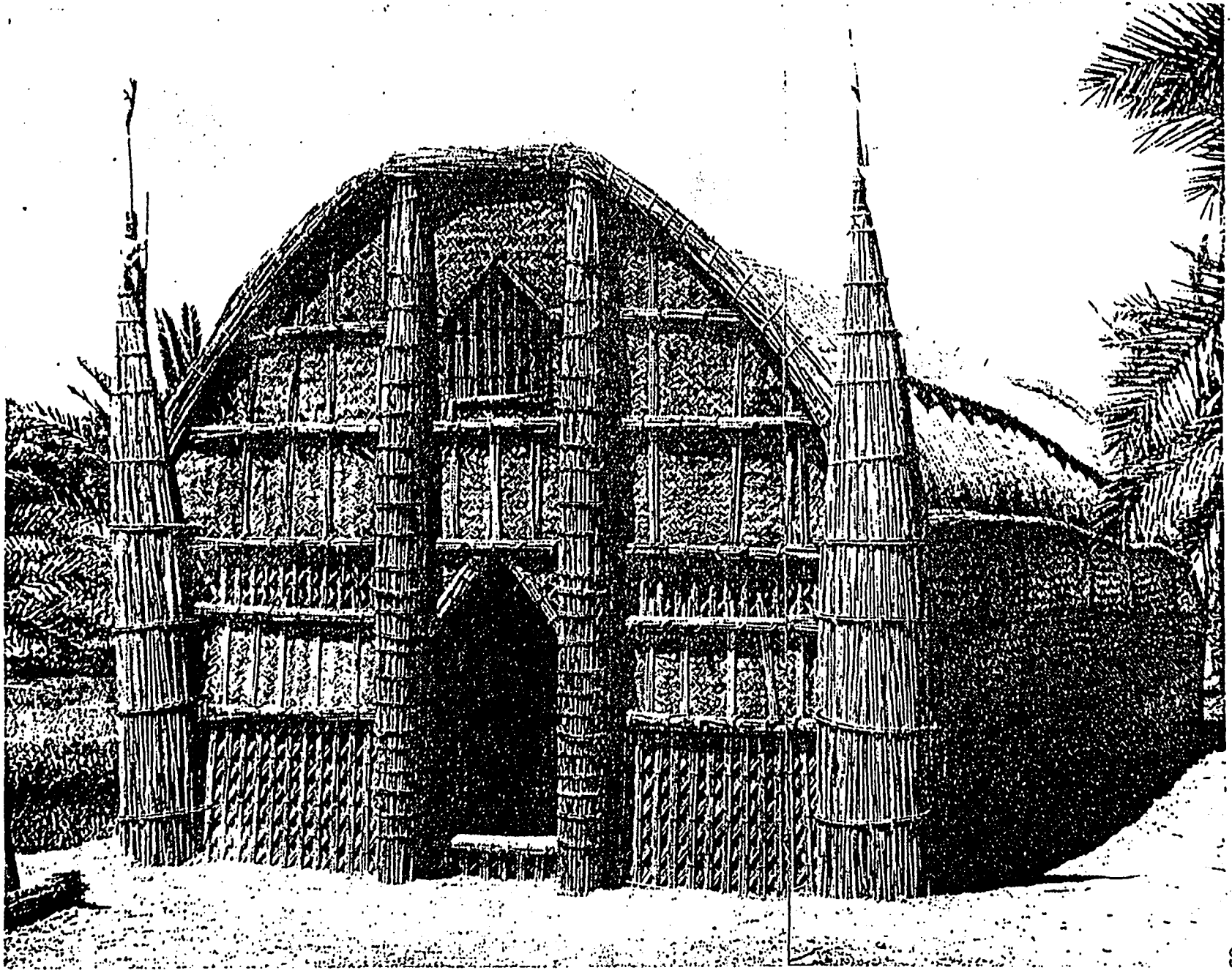


Figure 13. A modern Reed House in the Marsh Country of the Lower Euphrates.

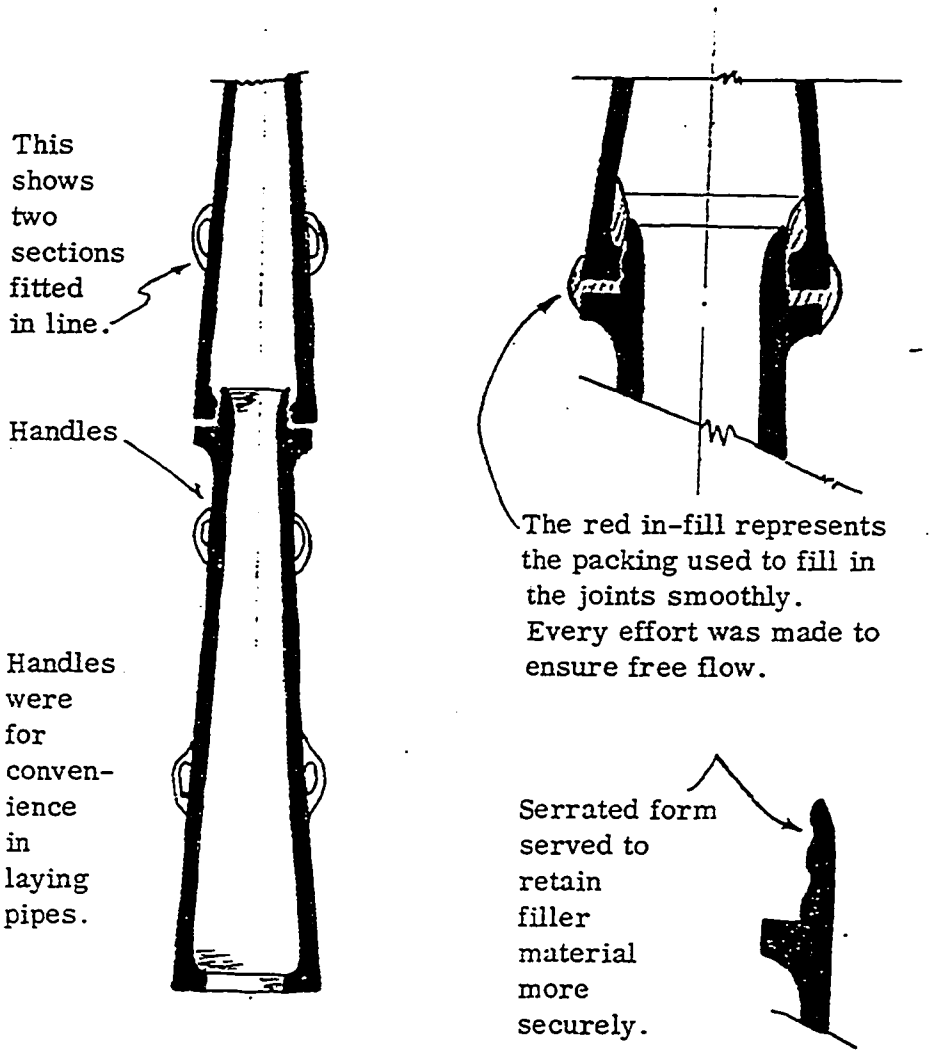


An exterior view of the 'Reed House' shown in the previous photograph.

Figure 14.

Some details of the plumbing found in the Palace of Knossos in Crete. It is dated in Middle Minoan I by Sir Arthur Evans. This would be somewhere about 2000 B.C., or slightly earlier. The sections are all made of clay, and are well baked.

The illustrations are taken from Evans' "Palace of Minos", MacMillan, Vol.I, p.143.



The design of these pipes is based on sound engineering principles. Turbulence is reduced to a minimum.

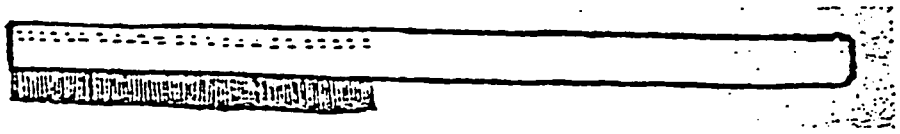
Figure 16.

In contrast with the sewage disposal system of modern Syrian towns this ancient 'main sewer' from Ugarit (or Ras Shamra) looks pretty impressive. It was built in the 2nd. millennium B. C., and is 9 feet underground, with room to walk in.

In the streets above, lead drains like this carried the water into the sewers, and kept the streets clean and dry.

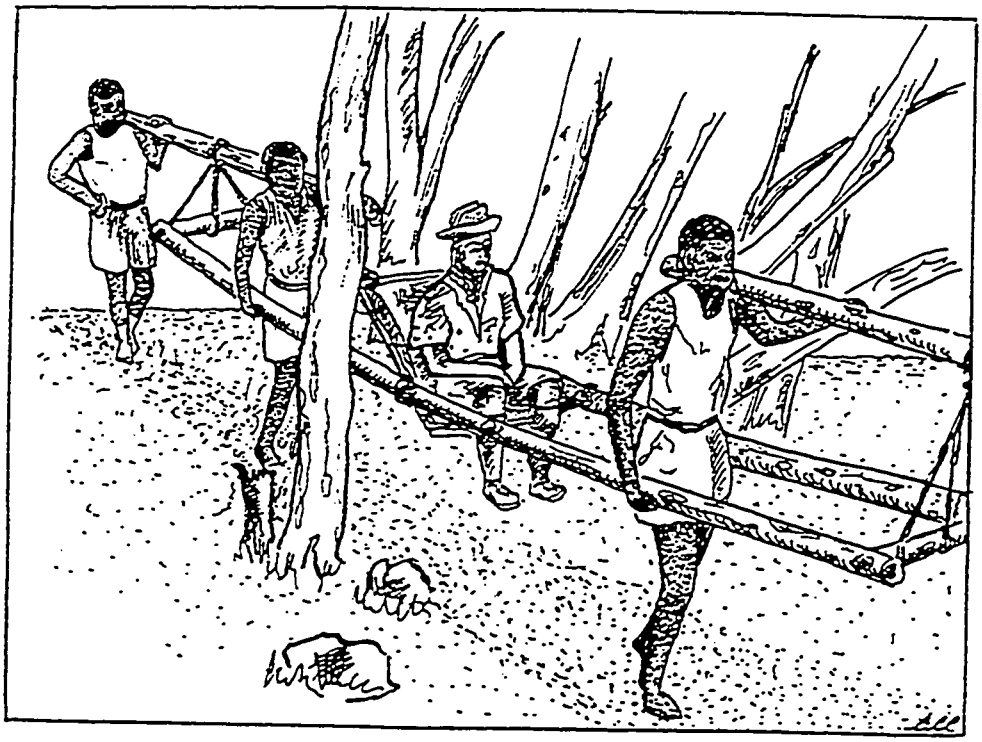
In the photograph, the holes are in process of being cleaned out. It is difficult to realize that this was made and installed 4000 years ago!

Figure 17.



The first toothbrush? Reproduced from the Chinese manuscript which dates its invention on June 25, 1498.

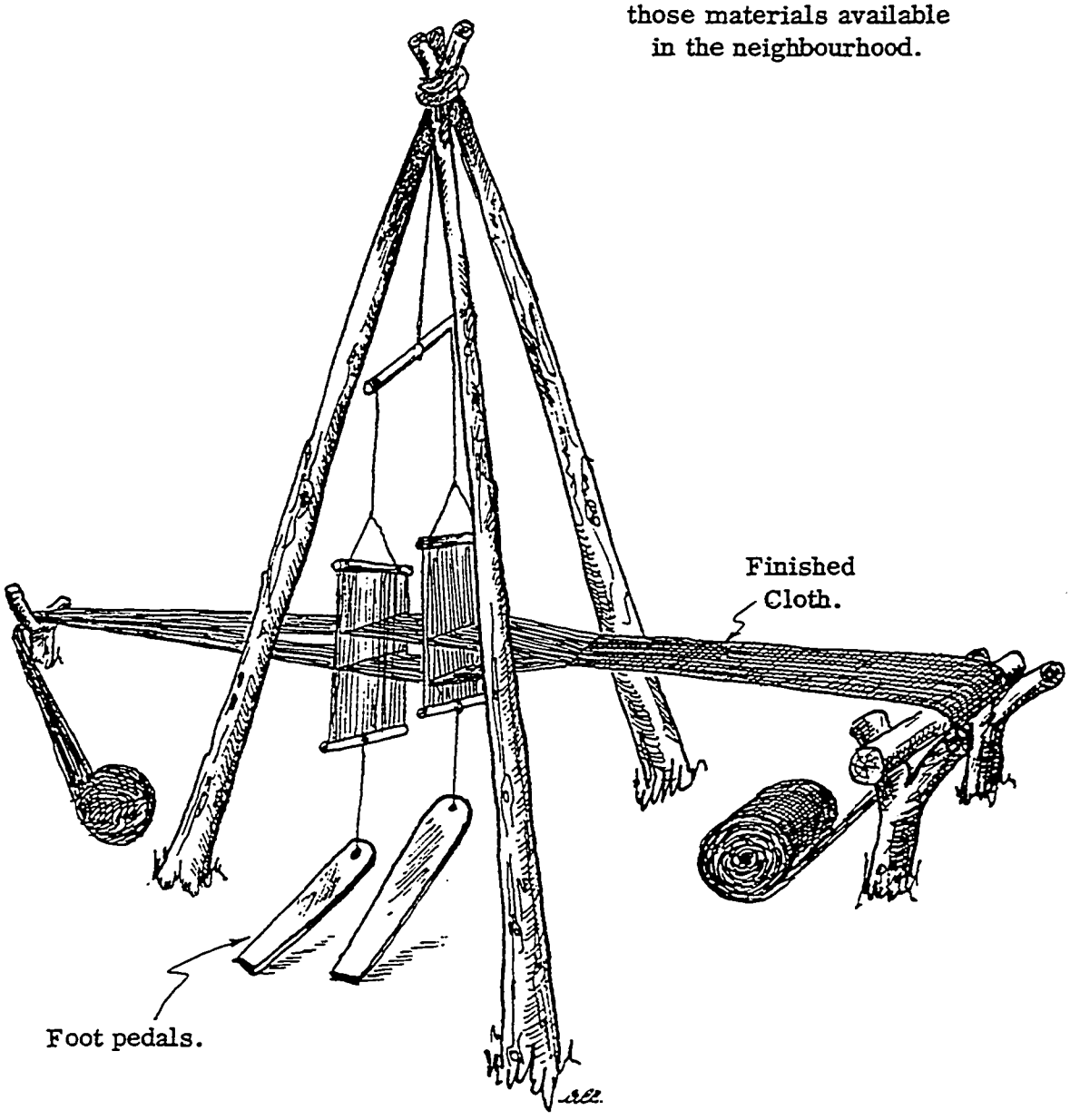
Figure 11.



A four-man Chair from French Equatorial Africa.

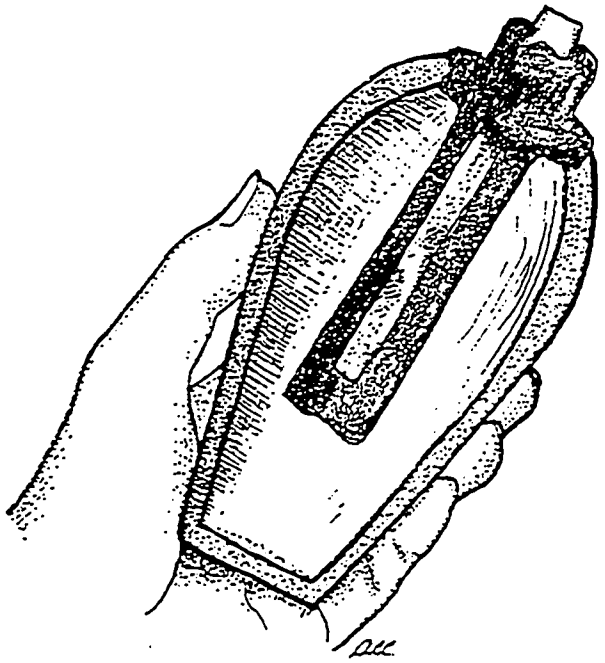
Figure 18.

A native loom whose design is common to many parts of the world, and which uses only those materials available in the neighbourhood.



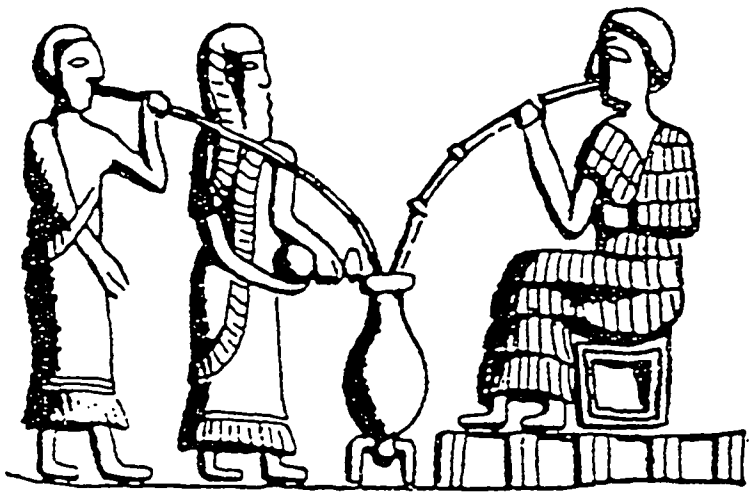
From "A History of Mechanical Inventions", Abbott P. Usher, Harvard Univ. Press, 1954.

Figure 19.



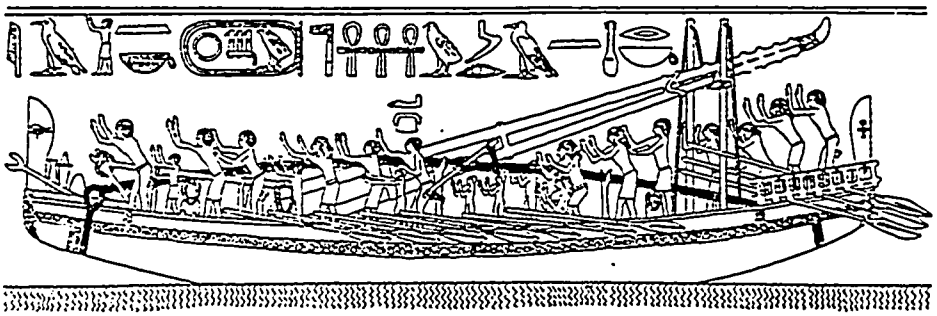
One of the Parthian batteries described in the Text, as reconstructed from parts found near Baghdad.

Figure 15.



Sumerians, drinking from Straws.

Figure 20.



An Egyptian sea-going vessel from the tomb of Sahure, c. 2700 B.C., showing the rope tensioner stretched from one end to the other, supported on a brace at the centre, and tightened with a torsion bar member on sound engineering principles.

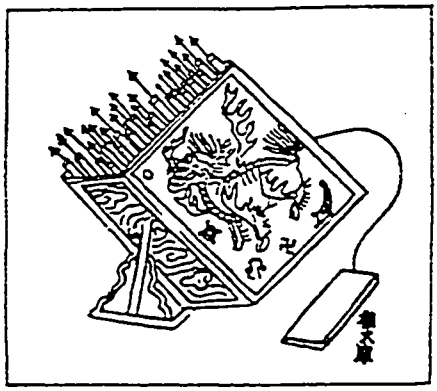
Figure 21.

A Chinese Rocket Weapon.

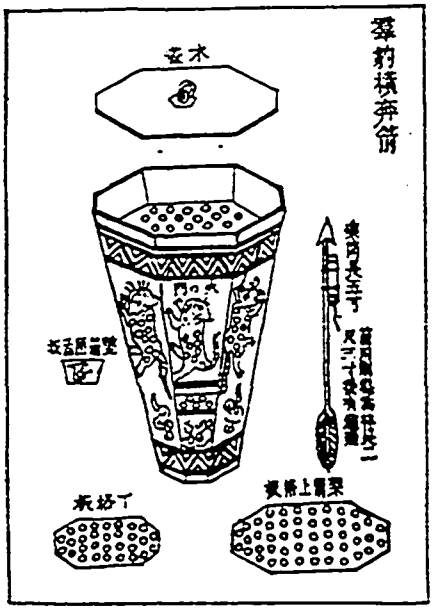
Figure 23.

Ancient Chinese 'rocket-arrows' and their launching devices. From the paper by Willey Ley, referred to in the text.

CHINESE may have used rockets as early as 1232. Here incendiary rocket arrows are launched from baskets.



LAUNCHER built by the Chinese had a capacity of 100 rocket arrows. It could be tilted to alter its range.

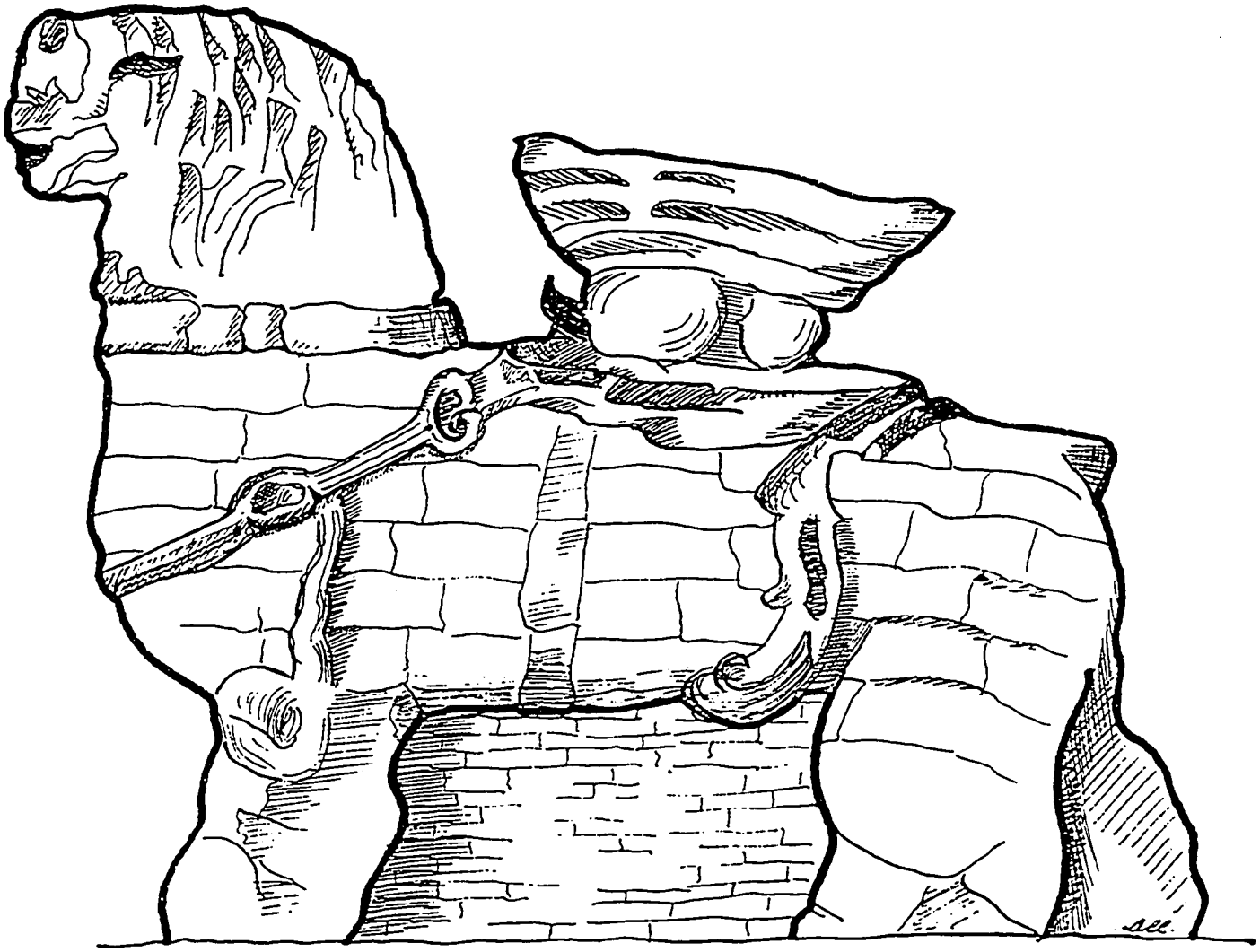


PORTABLE launcher had a capacity of 40 rocket arrows. These rockets had a range of some 400 feet.

Figure 22.

An illustration of the earliest known Cast Iron Stove from China as published in an advertisement by the Borg-Warner Corporation, in the Saturday Evening Post, of Sept. 8, 1951.

Figure 24.



Cast probably in 953 A.D., this may well be the largest single cast iron figure in the world. It stands in the yard of the Kai-Yuam Monastery in Ts'ang-chow. It is approximately 20 feet high.

Figure 25.

CHAPTER II

THE INDO-EUROPEAN CONTRIBUTION.

It is very difficult to extract oneself from a familiar cultural background sufficiently to view the achievements of other cultures objectively. It comes as something of a shock to discover how little we, of Western tradition, have contributed to the world's Technology. It seems so obviously otherwise. But a recognition of this fact is salutary in so far as it can influence our thinking about other cultures by making us far more respectful of them. Moreover, it may have a practical value. If we discover where our real strength lies, possibly we shall take more time to cultivate it. This could mean some changes of emphasis in technical education, at least at the University level.

Perhaps it would be a good thing to give a few bold statements about our lack of inventiveness – though they may seem manifestly wide of the mark. We have already mentioned the debt of the Greeks to the Minoans, and the debt of the Romans to the Etruscans. These creditors, in turn, owed much to Egypt, Anatolia, and Mesopotamia. Sir Arthur Evans wrote:[1]

> The proto-Egyptian element in early Minoan Crete is, in fact, so clearly defined and is so intensive in its nature as almost to suggest something more than such a connection as might have been brought about by primitive commerce. It may well, indeed, be asked whether in the times of stress and change that marked the triumph of the dynastic element in the Nile Valley, some part of the older population then driven out, may not have made an actual settlement on the soil of Crete. When it is realized how many elements drawn from the Minoan world lived on in that of Hellas, the full import of this very ancient indebtedness to Egypt at once becomes apparent. Egyptian influences, hitherto reckoned as a rather secondary incident among the later

classical movements, are now seen to be at the very root of our civilization.

Such threads are now even clearer than when Evans wrote. Later on in our history, and via the Arabs, we became indebted both to native Africa and the Far East; and via the explorers and pioneers of the New World, we became greatly indebted to the American Indians. Our cultural and technical heritage has manifold roots. It is not difficult in the present state of knowledge to write down a list of some 300 basic elements or items of our technology which we have borrowed from non-Indo-European sources, and which cover almost the whole range of modern civilization, not excepting the use of electricity.

Admittedly we have done much to modify, extend, improve, and increase the general availability of the things we took over from these other Cultures. We have already quoted from M.D.C. Crawford to the effect that in the realm of natural fibres and dyes, we contributed little or nothing to the Technology of Textiles. But, inspired by the desire to be independent of outside sources of raw materials, we have succeeded in producing synthetic fibres which allowed us to develop certain new techniques of fabrication, such as extruding in sheet form and heat sealing seams instead of stitching them. Yet it remains fundamentally true that we have made no real advance upon the textile skills of non-Indo-Europeans who used natural fibres and dyes and therefore provided our fundamental knowledge, and by their non-woven materials inspired us to attempt alternatives.Nor did we advance the world's resources in other directions either.

Carleton S. Coon says:[2] "The linguists tell us that the Indo-European speakers did not initially domesticate one useful animal or one cultivated plant."

But there is one exception possibly – a rather amusing one! George Sarton quotes William H. Hudson in 1892 as having remarked:[3]

> It is sad to reflect that all our domestic animals have descended to us from those ancient times which we are accustomed to regard as dark and barbarous, while the effect of our modern so-called humane civilization has been purely destructive of animal life. Not one type do we rescue from the carnage going on at an ever increasing rate all over the globe.

The picture has changed slightly, since. But Sarton adds, in commenting on this remark of Hudson's, "The only animal domesticated in historic times is the ostrich: this was a poor achievement which was justified only because some women and generals wanted feathers for their hats."

W. J. Perry, whose reconstructions of history are not too well accepted, was nevertheless essentially correct when he wrote:[4]

> The Celts, like the Teutons, never invented anything; the whole of their culture shows signs of derivation from the Mediterranean.

Lord Raglan says the same thing with respect to the Romans:[5]

> The old Roman ritual gave little encouragement to inventiveness, and later cults were imported ready-made from the East. As a result, the Romans invented almost nothing.

And to quote Joseph Needham again,[6]

> The only Persian invention of first rank was the windmill ... Unless the rotary quern be attributed to them, the ancient Europeans of the Mediterranean Basin launched only one valuable mechanical technique, namely, the pot chain pump...

In another direction, J. Grahame Clark[7] emphasizes how little Europeans contributed to the labours of the American Indians within their own environment: "During the four

centuries since the Discovery (1492) the White Man has failed to make a single contribution of importance."

Curiously enough this has been true also of the Semites who, although not Indo-European, should nevertheless be distinguished where possible from the non-Indo-Europeans whom we have been considering thus far. Speaking of the Babylonians and Assyrians, both Semitic, who succeeded the Sumerians in Mesopotamia, Vere Gordon Childe says:[8] "In the next two millennia one can scarcely point to a single first class invention or discovery...."

Childe makes two exceptions – the alphabet, and iron smelting. But the latter is doubtful. It seems more likely that the credit must be to the Hittites for this – rather than to the Babylonians. The raw materials did not exist in Mesopotamia as far as I know. Ralph Linton,[9] referring to the same people, says categorically: "Not a single item of later technology was introduced by the invading Semites."

The Arabs are largely (though by no means entirely) Semitic also. Speaking of them, Lord Raglan, after discussing the uninventiveness of the Romans, says:[10]

> Much the same can be said for the Moslems. There was a period of mild inventiveness while their religion was settling down into its various sects, but since that process was completed about 900 years ago, no Moslem has invented anything.

Yet this is quite contrary to popular opinion. Their role as carriers from the Far East and from Africa, has led to the somewhat widespread belief that they originated what we received from them. But on this point Rene Albrecht-Carrie has this to say:[11]

> What is really relevant in this context is that the Arabs – or rather the wide variety of peoples whom they brought under their control and who came to pass under their name – were not so much innovators as collectors, organizers, synthesisers, and, most important, carriers of the contributions of other times and peoples. This is not to deny or minimize the crucial importance of their role or to ignore the fact that they made some valuable contributions of their own: but it remains largely true that the initiation of the "Scientific Revolution" was not of their own making. Nevertheless to this making they contributed mightily ... but the Arab contribution, was, to repeat, mainly in the form of a transfer of ancient learning....

St. Chad Boscawen, one of the earlier cuneiform scholars to make known the findings of Archaeology in the Middle East, came to the same conclusion after studying Babylonian civilization:[12]

> There is a powerful element in the Semitic character which has been, and still is, a most important factor in their national life: it is that of adaptability. Inventors they have never shown themselves to be.

James H. Breasted illustrated this very clearly in pointing out how much the Babylonians borrowed from the Sumerians whose land they had invaded and conquered. He wrote:[13]

> Some of the Semites now learned to write their Semitic tongue by using Sumerian cuneiform signs for the purpose. The Semites in time therefore adopted their script, their weights, their measures, their mathematics, their system of numerals, their business terms, and a large measure of their judiciary systems.

In a similar vein, R. F. Grau[14] pointed out that the *pure* Arabs developed "no new industry nor art [by which he means Technique], nor trade." The only thing they did invent was a style of architecture. He holds the same to have been true of modern Jewry.

It is not altogether clear to me how much the Arabs did actually contribute. H.J.J.

Winter[15] credits them with quite a few technical achievements. Yet he does say that in "the so-called Golden Age of Islam, Science owed its importance largely to the Persian contribution." He also remarks that the language of Iran had assumed a new significance, and that those who wrote in this language made the greatest contribution. This, it seems to me, tends to favour my argument, for the language of Iran is within the Indo-European family. It is not then so surprising to find that some of their best known writers, such as Ibn Sina (980-1037), were noted for their "theoretical postulates." The reason for this observation will become clearer in the following Chapter. Ibn Sina in fact placed mechanics in the lowest level of a great scheme of speculative philosophy, according to Winter. Extracts are given by Winter of some of Sina's postulates, and these are completely in the tradition of 'modern' scientific observation.

Later works tended, it seems, towards mechanics and away from pure speculation as the Persian influence waned; only two Islamic treatises being particularly outstanding, one of which is entitled *The Book of the Knowledge of Ingenious Mechanical Contrivances*. Its main interest was in elaborate water-clocks – which, as we have seen, were derived from China and therefore not original with the Arabs. The other of these two outstanding books concentrates on various types of balances, with a clearly practical end in view particularly in connection with coinage and trade. Winter mentions the fact that the Arabs widely exploited natural sources of power especially wind-mills and water-mills. Again, the former was borrowed from Persia and the latter probably from China.

Yet it is obvious that Jewish people *have* contributed to the Technology of

civilization: for example, Weismann in Chemistry, and Einstein in Physics. But there is a consideration of some importance here. In a paper which is nearer to my Thesis than any other I have yet come across, Jessie Bernard makes this significant observation:[16]

> It is not the Jews who remain within their own cultural setting who make the greatest contribution.... It is only, as Veblen says, "when the gifted Jew escapes from the cultural environment created and fed by the genius of his own people, and becomes a naturalized, though hyphenate, citizen in the gentile republic of learning, that he comes into his own as a creative leader in the world's intellectual enterprise."

Jessie Bernard points out that it is not the result of mere chance that the great revolutionary ideas of our time – Freudianism, Marxism, and Einstinian relativity – were promulgated by Jews who were no longer in any sense orthodox. She might also, perhaps, have mentioned St. Paul, who rejecting Judaism became an apostle of a new faith to the Gentile world.

Now this is a generative idea. It suggests possibly that any non-Indo-European can become 'Western' in his outlook, provided that he adopts, at least to some extent, the habits of thought and the worldview of the Westerner. It is not merely a matter of adopting the mechanics of Western Civilization. This, I think, is an important point. It was with this in mind that I said at the beginning of this Thesis that adoption of the Scientific Method by non-Indo-Europeans involves some modification of the grammar of their language. The vocabulary of any people may change quite rapidly at times, but grammar (ie., the structure of language) tends to be preserved – because apparently it reflects a way of looking at things. Ernst Cassirer[17] says in a paper on the influence of language on

the development of scientific thought: "Modern linguistics does not hesitate to speak of a 'philosophy of grammar'." Though I am aware of the controversy here, I think it is generally agreed among linguists that we do not think conceptually without symbols. Habitual thought patterns of a 'philosophic' nature will therefore be related to established grammatical forms. This was an area investigated with very great fruitfulness by Benjamin Lee Whorf,[18] and of course by Susanne Langer,[19] and a host of others. It will be discussed in Chapter Three more fully.

Philosopy and Practical Wisdom

In the meantime, while non-Indo-Europeans are highly inventive, they have not been particularly if at all philosophical. In the opinion of many writers they have studiously avoided speculation about anything that was not of an entirely practical nature. It is partly a question of definition. Needham speaks freely enough of Chinese philosophy, but one wonders whether he is really using the term in the accepted sense. If our own definition is permitted to stand for the present, none of these people whose ingenuity we have examined really produced philosophers.

The only organized attempt to present an opposite view, as far as I know, is that made by Paul Radin[20] in his book, *Primitive Man as Philosopher.* I have found it difficult to assess this volume fairly because I had the feeling all the time that the best illustrations of primitive philosophy (mostly given from among the North American Indian tribes) could so easily be the result of Western influence. How is one ever to know for sure that a man's views are "native" as it were, when he has lived much of his adult life within the

orbit of Western thought? In a lecture given in the University of Toronto, E. Carpenter of the Anthropology Department, stated that some Rorschach tests had been administered in primitive societies to individuals who were considered by their own culture to be abnormal, such as Eskimo shamans, etc. "The results showed nothing, except in several instances a tendency towards abstract thinking," Carpenter claimed.

This is a slender platform for any argument, but certainly it does not stand against our view that primitive man does not normally concern himself with abstractions at all. If he does, he may be classed by his own culture as abnormal.

Lévy-Bruhl[21] was one of the strongest exponents of the view that primitives have a different kind of mentality from ourselves. It is unfortunate that his description for this – "*pre*-logical thought" – was misunderstood to mean *il*-logical thought. Native people are not illogical. Both they and all other non-Indo-Europeans tend to adopt different premises, and on these different premises to erect a quite logical superstructure. This can be demonstrated ad infinitum. Because we cannot understand one of their premises, namely that Nature is 'personal,' we tend to reject the superstructure on the grounds that it is not rational. We shall consider this later. And Lévy-Bruhl pointed out that one cannot define a society by one or two of its members, so that the discovery of one or two odd individuals who show some liking for the abstract does not tell us much about the culture as a whole. Following August Comte, he said:[22]

> "The highest mental functions of man remain unintelligible as long as they are studied from the individual alone."

Thus a few exceptions do not indicate too much. Radin at times seems to be confusing 'a philosophy of life' held by one or two outstanding members of a culture, with Philosophy. Maritain[23] admits that all peoples have a little Philosophy too – but through 'sacred tradition' as much as anything, rather than by personal creation. This does not make a man a Philosopher.

Radin admits Indo-European influences, but considers this of no great importance. He says:[24]

> For our purposes, it is immaterial whether some of this speculation is connected with recent European influence or not, since all I am desirous of proving is that a few individuals in every community indulge in speculation and enjoy it. Some of the examples I shall quote are definitely connected with recent Christian influence, but these are particularly instructive because the questions they develop are often quite new to Christian theology.

My own feeling is that this misses a point that makes all the difference; namely, that the Christian influence brought with it a new worldview and inevitably introduced modifications of language and of thought patterns.

One of his examples is so obviously not original, since it reproduces (almost word for word at times) the Genesis account of man's creation, that one wonders why it is used at all.[25] He also admits that,[26]

> It is from instances where we know European and Christian influence to have been definitely present that our best evidence for the existence of thinkers, and for the philosophical quality of their thoughts, can be derived.

But this admission virtually proves my point! Yet Radin's book is provocative. The Winnebago Indians, with whom he is best acquainted, did much real thinking. Their

poetry is quite remarkable. This I feel, ought to be said in fairness to the author of this very readable work, for I am aware of a strong prejudice that undoubtedly makes it far easier for me to see the borrowed elements than any original ones which may exist. Yet, of these people, Radin says "the Winnebago have been in contact with European civilization since the second quarter of the 17th century."[27] This is a long time. Throughout the 18th century, the White Man settled increasingly among them.

Jacques Maritain sums up my own convictions in this matter by saying:[28]

> Philosophic speculation... is unknown to all the so-called primitive races. Indeed, even of the civilizations of antiquity the greater part either have possessed no philosophy or have failed to discover its true nature and distinctive character. In any case philosophy only began to exist at a very late period about the eighth and especially the sixth century B.C.

Maritain proceeds thereafter to show that the Egyptians did not produce philosophers either – in spite of popular opinion to the contrary. They bent their mental energies to very practical ends, even their 'theology' being entirely a utilitarian affair. As Martin Engberg[29] says: "Nowhere is there any indication that Egyptians were interested in theoretical problems."

And Sir Alan Gardiner[30] in the introduction to his Egyptian Grammar put the matter even more forcibly when be said: "No people has ever shown itself more averse from philosophical speculation, or more wholeheartedly devoted to material interests."

Even in more popular articles where one might least expect to find it, authorities make the same admission, thus cutting right across a very common illusion about these remarkable people. William Hayes remarks:[31]

> Though intensely devout, the ancient Egyptian had neither the mental nor the spiritual equipment necessary to the creation or even the adaptation of a great religion. An analysis of the Egyptian religion shows that it consisted of at least four unrelated cults or phases, no one of which ever passed beyond what we should regard as a primitive stage ...
>
> Though intelligent and quick to learn, he had a mind of the practical unimaginative type. He was a materialist, and not given to deep speculative thought, and was unable either to evolve or to express a purely abstract idea.

Writing for a more scholarly audience, James Newman, speaking of the Rhind Papyrus, says:[32]

> The Egyptians, it has been said, made no great contributions to mathematical knowledge. They were practical men, not given to much speculative or abstract inquiries. Dreamers were rare among them, and mathematics is nourished by dreamers - as it nourishes them. ...
>
> The Rhind Papyrus, though it demonstrates the inability of the Egyptians to generalize, and their penchant for clinging to cumbersome calculating processes, proves that they were remarkably pertinacious in solving everyday problems ... and uncommonly skilful in making do with the awkward methods they employed.

Philip E. B. Jourdain states that:[33]

> The Egyptians' geometrical knowledge was of a wholly practical nature. For example, the Egyptians were very particular about the exact orientation of their temples.

Jourdain explains how the regular flooding of the Nile continually washed away or concealed land marks and boundary lines, so that re-surveying was an annual chore. This led early to the development of rapid means for drawing right angles, etc., and indeed led to the word 'Geometry' (i.e., land-measuring) which the Greeks gave to the mathematics they took over from the Egyptians. But unlike the Greek mathematics, Egyptian mathematics was purely a practical affair. As Jourdain put it:[34]

> The Rhind Papyrus contains a fairly complete applied mathematics, in which measurement of figures and solids plays the principal part; there are no theorems properly so called; everything is stated in the form of problems, not in general terms, but in distinct numbers.

How completely different was the product which Thales derived out of this heritage. It was as Jourdain says a 'transformation'; he no longer presented his conclusions as a mere induction from a large number of special instances, as probably was the case with the Egyptian geometrician. But rather:[35]

> The deductive character which he gave to the Science is his chief claim to distinction. Pythagoras (born about 580 B.C.) changed geometry into a form of abstract science, regarding its principles in a purely abstract manner, and investigated its theorems from the immaterial and intellectual point of view.

This, then, in the field of mathematics: in medicine the same picture is presented. Ileen Stewart, in dealing with one particular aspect of early medical practice, says this:[36]

> Much of the medical lore of the Egyptian became the heritage of the Greeks as they fashioned their civilization in the last few centuries B.C., at the eastern fringe of the Mediterranean.
>
> The knowledge they inherited was essentially factual, the accumulation of Egyptian observations and experience. The Greeks attempted to put these facts together and derive a systematic pattern in nature. Many of their interpretations are still tinged with mysticism, but were philosophical and logical as the Egyptians had never been.

The Ebers Papyrus, dated about 1500 B.C., purchased in Luxor is 1872 from an Arab by a German Egyptologist after whom it is named, shows how extensive the knowledge of the Egyptians was. Their medicine was by no means a mere jumble of magic formulae and otherwise useless substances whose only value was as a kind of placebo.

The Ebers Papyrus alone mentions over 700 drugs and lists numerous prescriptions

for specific illnesses. Most of these are polypharmaceutical and contain up to 35 ingredients. Some are still valid today. Among the drugs prescribed are castor oil, opium, squill, honey, copper sulphate, and sodium bicarbonate, as well as magnesia, iron, and lead, peppermint, anise, saffran, juniper berries, gentian, colchicium, and epsom salts. It contains some 811 such prescriptions.

Our knowledge of their achievements is quite extensive in this area. We have a number of other papyri, such as the Edwin Smith Papyrus, 1600 B.C., dealing with surgery; the Lesser Berlin Papyrus, 1600 B.C., dealing with magic; and the Kahum Papyrus, 2000 B.C., dealing with gynaecology and animal medicine.

Speaking of their astronomy, Jourdain says it was "altogether concrete and empirical" - undertaken for purely practical reasons.

James Baikie, in a well-known early textbook on Egyptian life and times, speaking of their so-called 'philosophers' such as Ptah-hotep, said:[37]

> All the evidence goes to show that the Egyptian was one of the most severely practical of men, who sought learning not for any joy in the attainment of truth for its own sake, but simply as a means to an end.... The wisdom of Ptah-hotep and Kagemni is in general of a canny, practical nature, concerning itself with the ordinary details of life and conduct, and inculcating prudence which, however praiseworthy, reaches no high ideals but is based mainly on self-interest.

This is in no way to belittle the extraordinary achievements of the Egyptians in every field of Technology. The daily lives of their upper classes must have been as comfortable as one can imagine, their physical needs supplied with elegance and good taste in marked contrast to the Greeks who initiated Science in Europe but whose lives were evidently

lived in rather comfortless austerity. Clive Bell[38] has pointed out that the disinterestedness of the latter in their pursuit of truth has been made a reproach to them. As he put it, "they sought truth for its own sake ... not as a means to power and comfort... The Athenians wished to live richly rather than to be rich." The life of a well-to-do Greek in classical times, so rich and complete in thought and feeling, was in most material blessings "indecently deficient" as he puts it.

Yet one should not suppose that either the Egyptians or the Sumerians or the Babylonians were illogical or lacked precision in their Technology.

R J. Forbes, speaking more particularly of their metallurgy, is careful to make it quite clear that the very opposite was the case. He says:[39]

> It is certainly not true that pre-classical Science [i.e., Technology, ACC] is nothing but a mass and a medley of fantasy and detective observations. The more we get to know of it, the better we observe that it was a model of precision and practical classification as far as the means of those days went. Pre-classical Science was a-logical; it did not *want* to explore or to understand structures and mechanisms. [Emphasis mine]

What has been said of Egypt applies to all the ancient Middle East Cultures. The Mesopotamian Cultures produced a highly complex mathematical knowledge as we have seen. Yet here again, all their tables are presented to us much as statistical tables tend to be – 'findings' resulting from actual cumulative experience. There *is* no theory. As Benjamin Farrington put it:[40]

> We are in the presence of abundant evidence of Babylonian mathematical ability, but their tables (of roots, cube roots, squares, and cubes, etc.) are offered to us like our own practical tables for calculating interest and so forth, *without proof or theory*. So that as far as the evidence goes, Babylonian arithmetic is

under the suspicion of being largely empirical.

In both Babylonia and Egypt we therefore have evidence of an extensive manipulation of figures, yet in neither case did it ever disengage itself from practical applications, nor become organized as a logical series of deductions from a few self-evident principles capable of extension by abstract reasoning into a true Science. There was no Babylonian or Egyptian Euclid.

Alfred North Whitehead, speaking of how the Arabs transmitted to Europe the mathematics thus derived from the Middle East, argues that it was in their 'classification' ability through which they made their most important contribution. He holds that classification is a halfway house between the immediate concreteness of the individual thing and the complete abstraction of the mathematical notions.[41] He then points out:[42]

> The Arabic notation had equipped the Science [of Mathematics] with almost perfect technical efficiency in the manipulation of numbers. This relief from a struggle with authentical details (as instanced, for example, in the Egyptian Arithmetic of B.C. 1600) gave room for a development which had already been faintly anticipated in later Greek mathematics.

Though it is anticipating somewhat, Whitehead's subsequent observation shows how the Indo-European contribution in the end redounded to the benefit of Technology as well. Thus he wrote:[43]

> Nothing is more impressive than the fact that as mathematics withdrew increasingly into the upper regions of ever greater extremes of abstract thought, it returned back to earth with a corresponding growth of importance for the analysis of concrete fact.

As we shall endeavour to show, Science developed by the play of philosophical minds

upon the data of Technology – and of course, using the skills of the latter in the manufacture of instruments of measurement. And it is well established that Science drew far more from Technology during the first few centuries of its development than it ever contributed, as the third volume of Singer's *History of Technology* makes clear. Stafford Hatfield remarks that Scientists have in fact invented remarkably little – except in ideas. Thus of the 21 – presidents of the Royal Society, only 4 invented anything, and of 174 recipients of the Copley Medal, only 12 invented anything. Moreover, a consideration of these 'inventions' shows that they were sometimes more in the nature of extensions of existing ideas than truly original contributions. As Hatfield puts it, "*superficially* regarded, the scientist is discovering what is there, while the inventor is creating what has never existed before."[44] He does not feel this is absolutely true, for it makes such 'inventions' accidental by-products of a search for something else. This is by no means the case in applied research, but pure Science must surely result in 'accidental' discoveries in this sense, rather than in inventions. It thus gives us one clear distinction between Science and Technology. The same author points out how the most important discoveries are not the result of a search for solutions to practical problems. As he says:[45]

> Dewar invented the vacuum flask, Einthoven the string galvanometer, Aston the mass spectrograph, Crookes the X-ray tube, quite "by the way" in the course of pure research and without any thought of the general utility of these instruments. The same is true of innumerable chemical methods. But the highest order of creative effort is exemplified in the great hypotheses which in the last marvellous 50 years of Science have sprung from the brains of Einstein, Rutherford, Bohr, Planck, de Broglie, Heisenberg, Schrodinger, and others. These are tested, like technical inventions, by trying whether they will work. But it is obvious

> that an aeon of experimenting would not discover them in nature, but only result in a mountain of facts without any structure whatever.

When primitive people use some chemical in conjunction with their 'magic' they are completely indifferent to experimenting with it. This is beautifully illustrated by a story told recently over the BBC and reported in the *Listener*.

E. H. Robinson[46] tells how E.Evans-Pritchard visited the Azande, an African people and discovered that they were using a certain method to get positive or negative answers, which depended on giving a chicken a poisonous substance called *benge*. If the chicken died the answer was Yes, or No, depending on which answer the spirits had been asked to give. Evans-Pritchard asked what would happen if they were to administer a double dose to a chicken which had recovered from the usual dose. The Azande were simply not interested. No one has been fool enough to waste good oracle *benge* in making such a pointless experiment. Only a European could imagine such a stupid waste of good material! In fact, Evans-Pritchard says that were a European to make such a test in which Azande opinion was proved wrong, the natives would not be impressed. They would simply stand amazed at the credulity of the European. If the chicken died, they would say it was not good *benge* - the very fact that the chicken died would prove it! There is absolutely no desire to speculate – and no experiment is ever undertaken merely to satisfy 'idle curiosity.'

In editing a valuable collection of Papers published under the title *The Intellectual Adventure of Ancient Man*, and later republished under a new title *Before Philosophy*, H.

Frankfort opens his introductory remarks with the following observation:[47]

> If we look for "speculative thought" in the documents of the ancients, we shall be forced to admit that there is very little indeed in our written records which deserves the name of 'thought' in the strictest sense of the term. There are very few passages which show the discipline, the cogency of reasoning, which we associate with thinking.

This volume contains a number of papers dealing with Egypt, Mesopotamia, and the Hebrews. There is unanimity on this point. The reasons for the absence of Science are in each case traced to a certain mental attitude towards the world around, i.e., towards Nature, organic and inorganic, coupled with a strange disinterest in metaphysical problems, which discouraged certain activities such as experiment and certain forms of thought essential to the development of the scientific attitude.

China presents a more difficult problem. This is partly because in recent years more and more research into their literature has been made available to Europeans, and considerable difference of opinion has existed among the authorities to the significance of some Chinese speculations. For example, Needham feels there is some justification for discerning in the writings of the neo-Confucianists certain forecasts of modern scientific theories regarding the nature of matter. He holds that the Sung philosophers, in their view of Nature as a kind of balanced system of opposing forces, were almost ready to reach the conclusions of Bohr and Rutherford in the field of electricity.[48] On the other hand, one recent reviewer of second volume of Needham's *magnum opus*, Homer H. Dubs, who is both a Chinese scholar well able to understand the Chinese Classics and appears to be a Philosopher in his own right, believes that Needham is misguided in his conclusions here.

Dubs praises much of Needham's work, but feels that at times he mistranslates Chinese texts because he really has not mastered Chinese philosophy. As he says, "Classical Chinese is such a concise language that one must first understand a philosophy before translating it."[49]

Yet at the very beginning Needham has tried to indicate that caution is required in interpreting Chinese philosophy because "in China the word Philosophy did not quite mean what it came to mean in Europe, being more ethical and social than metaphysical."[50]

This, it seems to me, is of fundamental importance, for it means that such 'philosophers' as China produced, were really only concerned with practical problems. Not, indeed, problems of mechanics always, but still *practical* problems; for after all, human behaviour and interaction is a very practical matter!

This is no new thought. While Confucius is commonly referred to as a philosopher, he actually was far from being one. Epiphanius Wilson, a Chinese classical scholar, points out the fallacy of this common assumption.[51]

> The strangest figure that meets us is the annals of Oriental thought, is that of Confucius. To the popular mind he is the founder of a religion, and yet he has nothing in common with the great religious teachers of the East. The present life *they* despised, the future was to them everything in its promised satisfaction. The teachings of Confucius were of a very different sort. Throughout his whole writings he has not even mentioned the name of God. He declined to discuss the question of immortality. When asked about spiritual beings he remarked, "If we cannot know men, how can we know spirits?"
>
> The influence of Confucius springs, first of all, from the narrowness and definiteness of his doctrine. He was no transcendentalist. His teaching was of the earth, earthy.... Even as a moralist he seems practical – the slight emphasis he puts on virtue of truth places him low down in the ranks of the moralists.

Needham writes much about the different systems of Chinese 'philosophy,' Confucianism, Taoism, Mohism, Buddhism, etc., which influenced Chinese thinking – but nothing that is presented in second volume of his great work, has convinced me that they were really concerned with the proper subject matter of Philosophy except as they were influenced by Buddhism. And even Buddhism, which originated in India where one branch of the Indo-European stock had left a clear mark upon the thinking of educated people, when transferred to China lost its truly philosophical character, though not immediately. Alan W. Watts says:[52]

> Although Buddhism was originally an Indian religion, emerging from the traditions of Hindu Philosophy, it did not attain its full vitality until the T'ang Dynasty in China – about the 8th century A.D. Philosophy, Buddhas, Bodhisattvas and religious rites are far less significant in China. Chinese Buddhism ceased to be a matter of other worldly mysticism ...
>
> When Buddhism first came to China, the method used for attaining spiritual illumination followed the lines of Indian Yoga; it was concerned with the practice of Dhyana – a profound state of consciousness obtained by sitting for hours, days, months, or even years in solitary meditation. But this did not really appeal to the practical spirit of the Chinese, who wanted a Dhyana that could be applied to everyday life.

It seems that we may speak of the Wisdom of the Chinese, as we may speak of the Wisdom of Ptah-hotep (and of the Sapa Inca Pachacuti or of Solomon)[53]: but we cannot perhaps properly speak of Chinese or Egyptian Philosophers.

It is my thesis that the evidence indicates that where Philosophy is absent, Science does not develop, because it is indicative of the absence of philosophic thinking. China had no Science because she had no Philosophers to exercise themselves and carry out experiments for the sheer delight of understanding, although the technical skills for

instrumentation were readily available. If one confuses Philosophy with practical Wisdom, one will confuse Science with Technology. It is, in both cases, a confusion of 'concerns' – neither Science nor Philosophy strictly concerns itself with 'practical problems' in the ordinary sense of the term. I think throughout his treatment of Science in China, Needham is overlooking this fundamental distinction.

Robert Multhauf, in a review of the second volume of this work says:[54]

> That [Needham] fails to produce a clear exposition of the relationship of technology to scientific thought is a weakness of the book, but an understandable one – since it remains to be accomplished in the relatively better known area of Western Science.

Multhauf then concludes that the Chinese world-view depended on "a totally different line of thought" from the West. It is an "organismic" world-view, a view which looks upon Nature as a Person, acting as an organism rather than a 'thing'. This attitude is quite characteristic of all Non-Indo-European peoples, who have therefore tended to favour the idea that man and Nature are personally related, a view reflected in Totemism. In our own Culture, man is again tending more and more to be made simply a fragment of the natural order. But instead of the marriage being achieved by the personalization of nature, it is achieved by the depersonalization of man.

In other Cultures this feeling of community with Nature, curiously enough, led to a peculiar callousness in the treatment of animals. It seems to have been the result of a feeling that the equality of man and animals gave both parties the same opportunity to defend themselves so that there was no thought of the 'defencelessness' of the latter. In

any number of cases, in fact, the animal had the advantage, and where his presence was not essential to the native for food or clothing, he would exult in being cruel because it was a kind of savage triumph he enjoyed in an effort to shame the defeated enemy.

In Europe, while man has not felt this community of spirit, he has taken the view instead that the stronger must protect the weaker, a certain 'love' of nature has resulted. It is a curious kind of inversion.

Now Taoism, according to Needham, differs from Confucianism in this respect that while Confucius said man must achieve social security by dominating nature, the Taoist said this social security will be achieved more successfully by attempting to gain an insight into nature's workings so that one may no longer be afraid of its power. This does not encourage experiment however, for such an activity would be almost rude! It means only study and observation. And even this involves no theorizing. One merely observes and learns, though technical aids in this are entirely in order, such for example as astronomical instruments – which were developed quite successfully.

Thus in speaking of Taoism, he says "the spirit of technology without science seems thus to be found within Taoist philosophy itself;" but he also points out that although Taoists never developed a systematic theoretical account of Nature, this did not at all prevent great progress in all practical Technology. As he says, "Technologists, lacking scientific background to their thought, have a habit of doing the right thing for the wrong reasons, and this was very true of China."[55]

A. L. Kroeber, the Dean of American Anthropologists and a keen student of Culture patterns, remarks:[56]

> It is significant that the Chinese have made many important inventions, but not one major scientific discovery. They have sought a way of life but neither an understanding nor a control of nature beyond what was immediately useful.

And a Chinese scholar, Lui Wu-Chi, writing of his own people's attitude to Confucianism, said:[57]

> The distinguishing features of Confucianism are many. First of all it is a moral system which is both practical and practicable. Without any trace of the metaphysical and the supernatural (i.e., of philosophy or religion) its contents are readily understood by the man in the street; and its ethical teachings, replete with wisdom and common sense, can be applied to daily life.

Philip G. Fothergill in a study of the history of evolutionary thinking, notes an interesting point here, namely, that among the Chinese, the primary elements are wood and gold, which are both substance of great value and utility. The primary elements of the Greeks on the other hand can be considered more as abstractions – earth, air, fire and water – as he says "equally useful, of course, but much more in the nature of ideas than things as the Greeks themselves conceived them."[58]

In fact the same writer draws attention to another important equation which the Greeks made. He remarks:[59]

> Unfortunately there is very little record and no extant continuous account at all of the development of the biological ideas of the ancient Chinese, Babylonian and Egyptian Cultures. The marvellous civilizations of the East have left few traces of their scientific thought. The Greeks... *regarded science as a branch of philosophy, and in fact did not discern between the two.* [Emphasis mine]

In many of these works on the history of Scientific thought, the Greeks are given credit for its beginnings as such. This may not be altogether justified. The Aryans in India played their part also – and independently.

In *Everyman's Encyclopedia*, under "Philosophy," there is the following observation:[60]

> It was not until man sought wisdom *for its own sake*, and with no religious or other motives, that he philosophized in the true sense, and previous theogonies, cosmogonies, etc., cannot strictly claim the title of Philosophy....
>
> The beginnings of Philosophy are as a rule attributed to the Greeks but the Indian ideas of the sixth century B. C., and much later, form an interesting parallel philosophic development.

A new history of Indian chemistry, edited by Prof. P. Ray, of Calcutta, has recently been reviewed by Partington in the British journal *Nature*. The reviewer makes reference to the relationships between Indian and Greek thought. He says, on this point:[61]

> The problem of the independent development of alchemy and chemistry in India is an extremely difficult one. It will no doubt continue to give rise to conflicting opinions and it may never be satisfactorily solved. The related problem of the Greek and Indian atomic theories also gives rise to controversy, although informed opinion now seems to consider that they may well have been independent.

It is quite enlightening to see how this philosophical bent expressed itself in India. Ralph Linton, another deep student of Culture patterns, points out that the Hindus were always highly receptive to new philosophic ideas, "but have shown an almost complete indifference to improved techniques of manufacture".[62] The material world was felt to be of so little importance that minor advances in its control were not considered worth the trouble of changing established habits. In the same connection, A. L. Kroeber observed

that "Hindu civilization is not only other-worldly, but mystical, rationalizing, and extravagant in its ethos."[63] And Robert Lowie adds that "the Hindus made their contribution in the field of pure mathematics, to which they added the concept of negative numbers"[64] – a highly abstract mental creation.

Miriam Chapin points out that Hindustani has an enormous vocabulary, and that it contains words for all kinds of scientific concepts and for "the most abstruse speculation."[65] It is a development out of the more ancient Sanskrit, a language well able to give expression to philosophical concepts. Speaking of a 'philosophy of grammar,' it is interesting to note that Hegel referred to this aspect of Hindu thought. In his *Philosophy of History*, he wrote:[66]

> The recent discoveries of the treasures of Indian Literature, have shown us what a reputation the Hindus have acquired in geometry, astronomy, and algebra, and that they have made great advances in Philosophy, and that among them Grammar has been so far cultivated that no language can be regarded as more fully developed than the Sanskrit.

Yet in spite of this capability, India added little to the world's scientific knowledge. The reason for this was probably because the technical background which might have been supplied by the non-Indo-European element in India was either lost (with the destruction of the Indus Valley Cultures) or made impossible by the reduction to a low caste of the survivors of those Cultures. Labourers and mechanics are lowest in the Brahma Caste System.

To sum up what has been said thus far, a somewhat lengthy quotation from Maritain beautifully draws these threads of evidence together. He writes:[67]

> It is not surprising that all peoples in the primitive stage of history were ignorant of philosophic speculation. But it is more astonishing that even certain civilizations were devoid of philosophy – for example, the *Semite*, and the *Egyptian*, which is, in this respect in the same category as the Semite. Despite the high level of scientific [i.e., technical ACC] culture reached by the intellectual aristocracy of these races, the sole philosophical conceptions, it would seem, which the Egyptians and Chaldeans possessed, were a few very general ideas, implicit in their religion, concerning the Deity, the human soul, and its state after death, and the precepts of morality. These truths, which, moreover (as in the case of every race), are purer the further back we follow their history, were never made the subject of rational study and speculation, but were simply accepted, as also were their scientific beliefs, as part of a sacred tradition. Religion took the place of philosophy, and from religion these races received certain philosophic truths; philosophy they had none. In this matter the Jews did not differ from their fellow Semites. Scornful of human wisdom and the achievements of pure reason, and, indeed, without aptitude for such investigation, they produced no philosophers (at least not before Philo) ...

This last remark is a striking observation, because Philo was a Jew who had rejected his own Culture and adopted the Gentile one, at least to the extent of receiving a Greek education and becoming thoroughly conversant with their systems of philosophy. Only such Jews became philosophers, as Jessie Bernard pointed out. Their inspiration was not from within their own culture.

Maritain then examines briefly the other Indo-European Cultures which lie outside the European area, such for example as the Persians and the people of India. He opens this inquiry with the words:[68]

> All the great Indo-European civilisations, on the other hand, manifest an impulse, which no doubt took widely different forms, towards rational and, in the strict sense, philosophical speculation.

In Persia this impulse expressed itself in a deeply speculative attempt to give a rational explanation of the vast problem of evil. This attempt took place under the

stimulus of Zoroaster, somewhere about the 8th to the 6th century B.C.

In India, as Maritain puts it:[69]

> When the original religion – the primitive religion of the Vedas – no longer proved sufficient to satisfy the intellectual demands or social needs of a more advanced civilization, philosophical notions, which seem to have originated as interpretations of sacrifice and other sacred ritual, but developed in a spirit hostile to the ancient traditions and the cult of the gods, found a home among the sacerdotal class and took possession of the priesthood... The priests... directed their worship no longer to the old gods, but to the undefined and secret forces of the Universe.
>
> This resulted, after a period of confusion, in the formation of a new system, Brahmanism (or Hinduism), which is essentially a philosophy, a metaphysic, a work of human speculation, was invested from the outset with the sanctions and attributes of a religion.

The subsequent history of Indian philosophy is then traced by Maritain very briefly, until the rise of a heterodox teacher, CakyaMuni, surnamed Buddha, who began to place more emphasis upon practice instead of contemplation and speculation, though his philosophy was grounded in (and may be regarded as a corruption of) the Brahman philosophy. Its practical emphasis appealed to the Chinese who soon abandoned most of what remained in Buddhism of the older Hindu speculative elements. In India, Buddhism was still a philosophy, though agnostic or atheistic – in China it became a practice.

Later on, Maritain touches upon the Chinese 'philosophers.' Of Confucianism, he says there can be no doubt that it was a form of enlightened selfishness, and completely indifferent to metaphysical speculation.[70] Of Lao-Tse, he speaks with some hesitation, doubting whether the interpretations of his teachings offered by modern Taoists are altogether valid.

Philip Jourdain, speaking of Egyptian mathematics and their solutions to certain practical geometric problems, says:[71]

> This method seems also to have been known to the Chinese nearly 3000 years ago, but the Chinese made no serious attempt to classify or extend the few rules of arithmetic or geometry with which they were acquainted, or to explain the causes of the phenomena which they observed.

It is remarkable how consistently this attitude of indifference to theory has therefore been reflected among non-Indo-Europeans, whether ancient or modern, primitive or highly civilized.

Science: Philosophy plus Technology

Thus it appears that we have a kind of intellectual bifurcation of mankind into two broad classes, technicians and philosophers, a bifurcation which seems to be culturally if not racially determined. Whether this is due to the nature of Indo-European as opposed to non-Indo-European language structure is a point worthy of some careful consideration. Has the mentality given us the language or the language the mental attitude? Certainly, as we shall seek to show in the next chapter, language is of great importance. As Harry Hoijer put it:[72]

> It is quite an illusion to imagine that one adjusts to reality essentially without the use of language, and that language is merely an incidental means of solving specific problems of communication or reflection. The fact of the matter is that the "real world" is to a large extent unconsciously built up on the language habits of the group.... The worlds in which societies live are distinct worlds, not merely the same world with different labels attached.

Susanne Langer has said that to master a new language is to enter a new universe. At

any rate, among Indo-Europeans there seems to be a certain calculated indifference towards, or at least an inability to detect, the practical usefulness of things. We have already mentioned how both the Hittites and the Chinese used cast iron. We use millions of tons of it now, too, but it is known that the Romans evidently 'discovered' it, but failed to recognize their discovery! R. J. Forbes says, on this point:[73]

> There is the possibility that some knowledge of Cast Iron reached the Roman Empire from the country where cast iron was invented, from China by way of the desert route. It seems to have been known to the Graeco-Roman world, as an accidental and useless product formed by raising the temperature (in smelting iron ores) but *since its nature was not recognized it was thrown away.* Even at Halstatt sites, for instance at Byciskala near Brno, cast iron pieces were found in the slag heaps.

How differently the Chinese treated this 'useless product'! Of course, this was a long time ago. Would it happen today? Well, the story of Kipping's discoveries in Chemistry is revealing.

E.G. Rochow, in his work on the Silicones, refers to Kipping's experiments. He points out that between the years 1907 and 1944, Professor F.S. Kipping published no less than 51 papers on silicone compounds which resemble organic compounds of carbon. It was a subject which he opened up himself and upon which he was for the entire period, the world's leading authority. In 1937 Kipping delivered the Bakerian Lecture to the Royal Society. In this he declared that he could see no future for such compounds, and remarked, "The prospect of any immediate and important advance in this section of Chemistry does not seem very hopeful."[74]

Yet Kipping never investigated methylsilicone, though he must have encountered both

it and similar products on hundreds of occasions. Since 1940 these products have assumed enormous importance and have opened up an entirely new branch of the Plastics Industry. In a recent article on these substances, Dermot Canning says:[75]

> Silicones have been called "magic sand with a thousand uses," and certainly the possible utilizations and applications of this resourceful chemical family do seem to be almost unlimited ...
>
> Silicone chemistry, although still very much in its infancy, has already shown that it is one of the most useful gifts science has bequeathed to us, and the intensive research now going on is certain to increase the applications of silicones still more.

Today it has been estimated that the silicones have come to represent somewhere in the neighbourhood of one third of the entire plastics industry. Yet his scientific mind missed their practical importance entirely. The same thing has happened with other chemical discoveries in the past. Insecticides were being synthesized over 50 years ago, but were not recognized.

There is a rather illuminating (and amusing) instance of this kind of lack of practical appreciation of what is available. This is in the area of electricity. It came as a very great surprise to the technical world when wet cell batteries were found in the Middle East, at least 2000 years old, and evidently used for the plating of metals. We have already mentioned this discovery. It is however by no means the only case of the use of electricity by non-Indo-Europeans.

Exactly one hundred years ago (1858), George Wilson[76], Regius Professor of Technology at the University of Edinburgh, presented a Paper before the then Canadian Institute, on the use of Electricity for therapeutic purposes in antiquity. Among those who

were using various species of electric eels, etc., in various ways, he mentions the Egyptians, Abyssinians, Etruscans, and the South American Indians, as well as some African tribes.

The Romans thus learned of these animals and the uses to which they had been put, from the Etruscans; and both Roman and Greek physicians copied the practice. Many classical writers refer to these fishes, including Plato, Aristotle, Cicero, Plutarch, Pliny, Oppian, Aelian and Athenaeus.

Subsequent references are to be found in the works of Scribonius Largus (1st century), Galen (2nd century), Aetius (5th century), and Paulus Aegineta (7th century). Questions began to be asked about the nature of the shock received from contact with these creatures by such writers as Aegineta who asked "Is not this an application of the principle of galvanism in medicine?" This was the beginning of a series of questions and experiments.

Meanwhile, headache, gout, rheumatism, and various more serious mental cases were given 'the shock treatment.' Its use in Abyssinia is described by Dr. Bradley in the following way:

> The patient is first strapped to a table, and the numbfish then applied successively over every organ of the body; the operation is reported to be both painful and successful.

African tribes along the Old Calabar River made therapeutic use of an electric fish found in the river to cure sick children, simply by putting such a fish into a bowl of water and leaving the child to play with it! Sometimes a baby was put into the tub first – and

then the fish thrown in. Humboldt stated that the American Indians used the species *gymnotus* in medicine, and the same author reports its use in Dutch Guiana, at Demerara for instance, to cure paralytic affections. Wilson concluded his paper with these words:[77]

> Writing as a physicist, I would remind naturalists, that it was the careful study of the powers of the torpedo (fish) that first enabled electricians to understand some of the most important laws of action of their artificial machines and batteries.

Cavendish tried to imitate the effects of the Torpedo fishes with electricity and as a result enunciated the difference between intensity and quantity, i.e., between amperage and voltage.

And so we find non-Indo-Europeans employing electricity in two forms but never apparently asking any questions. Then the Indo-European picks up the trail and begins to ask, Why? Through Galvani and Volta we come to Faraday, and it is here that the humour and surprise of the record comes in.

One of Faraday's great discoveries was the phenomenon of induction, without which modern electrical equipment would never have been possible. According to David Dietz, there is a story of a visit by Prime Minister Gladstone to Faraday's laboratory at the Royal Institution in London.[78] Faraday was then engaged in those experiments which led in time to the development of generators, electric motors, transformers, and a host of other things.

"What's the use of all this?" asked Mr. Gladstone. Faraday thought for a moment, and then replied. "Don't worry, Milord, you'll tax it yet!"

What really inspired Faraday was not the possible use of his findings which he quite probably did not see, but curiosity. As one writer on this famous man put it recently, "He wanted to know why electromagnetic induction occurred."[79]

Interestingly enough, a trade journal recently carried an article entitled "The Role of the Scientist and Engineer in Society," by L. R. Hafsted of the General Motors Corporation. Hafsted has a right to speak on this subject, for he is Vice-President of Research, a position of no mean importance. In his article he says:[80]

> A scientist's work is completed when an item of information is established and recorded. The same man who makes a discovery may choose, or be persuaded, to attempt to apply it to a practical problem. In this case he *ceases to be a scientist* and works essentially as an engineer. He is not motivated internally as a Scientist, but *externally by society*. [Emphasis mine]

This seems to me to contain several very important observations. It will be noted that he uses the word 'discovery' in relation to Science, just as Kroeber and others have been careful to do – and not the word 'invention.' He points out that when the scientist becomes an engineer (or technician) he has ceased be a scientist. Thereby, he underscores the fundamental difference between the two. And finally he remarks upon the fact that the scientist is motivated by an internalized urge to discover, the technical man by externally applied pressures demanding invention or creation to satisfy a recognized need in society. An excellent illustration of this is to be found Plutarch's account of how Archimedes had to be persuaded to put his genius to practical use to prevent the Romans from capturing Syracuse, and how he afterwards refused to leave any record of the devices he invented for this purpose.

I suggest therefore that the real contribution of non-Indo-Europeans has been in the field of *invention*: and of the Indo-Europeans in *discovery*. And that these both result from an attitude of mind, a feeling towards the Universe which is significantly different in the two classes of people. Each has its advantages. Properly wedded they produce the grandest results. Neither alone, as we can see, produces this high achievement; for in China a certain level was reached in a materialistic civilization beyond which it did not go; and in India, where circumstances left the intelligentsia without technical assistance, a mystical culture reduced the greater number of its vast population to almost abject poverty and privation.

Before closing this Chapter, one further observation is in order. In his study of Science in Antiquity, Benjamin Farrington has this to say:[81]

> After the death of Aristotle the renown of Athens as a centre of scientific research was rapidly eclipsed by Alexandria. Here Ptolemy, one of the great generals of Alexander the Great, had established himself as head of a portion of the vast empire Alexander had won. And the dynasty he founded in the new capital of Egypt, where a Greek court ruled over the ancient people of Egypt... patronised learning with lavish generosity. The Museum which the Ptolemies founded and maintained in Alexandria rapidly became the centre of a Scientific Movement that might have transformed society into a semblance of the modern world. Ancient society halted on the threshold of a modern age.

Why? Could it be because the Indo-European influence was slowly eclipsed by a Semitic, an Arab one?

In itself however, a philosophical or scientific mind is not necessarily a superior type of instrument to the inventive mind. It is not to our credit that we developed Science where non-Indo-Europeans did not. It is to everyone's benefit when the two contributions

become complementary. There is no room for racial pride here. As Abbott Payson Usher put it:[82]

> Although transcendental idealism is justly insistent upon the fundamental importance of abstract concepts and the analytic truths, the idealists misrepresent the processes of thinking and of evaluation when they represent abstract concepts as the highest and ultimate level of thought.

The indifference of Indo-Europeans to practical ends has been as marked as the indifference of the non-Indo-Europeans to speculation. As Lord Raglan says:[83]

> The Scientists of the 17th century were but little interested in the utilitarian aspect of their inventions. Their object was to cause wonder and surprise, to produce "a most incredible thing." Nothing was farther from their minds than the idea of developing their inventions for the purpose of altering the conditions under which they lived.

The scientist in his Ivory Tower may be a kind of heroic figure in our Culture, but he can also be a ludicrous one. James Conant[84] says "the scientific attitude is essentially that of the *savants* who, drinking to the next discovery, coupled with their toast the hope that it might never be of any use to anybody." And Robert Clark, to match this, makes reference to the great Irish mathematician William Rowan Hamilton, who, when he had developed a theory of quarternions in the middle of the 19th century, "was very pleased because it has no practical application!"[85]

CHAPTER III.

THE RELATIONSHIP BETWEEN LANGUAGE AND WORLD-VIEW

Perhaps this essay thus far will have served to indicate the contributions made by non-Indo-Europeans and Indo-Europeans, and to show the importance of interaction between them. Each in its own way has played a part, Technology being developed considerably earlier in human history than Philosophy, thus supplying the pabulum out of which men who were motivated internally by curiosity developed the edifice of Modern Science, and thereby carried Technology much further along its way.

A useful illustration of this process of interaction is to be found in the story of the Fire-piston. This is a device known over a wide area of Oceania, in a variety of forms which nevertheless all operate on the same principle.

This little gadget is used by natives to produce a light, and they do it as quickly as a man can strike a match. It is a small cylinder of bone or bamboo as a rule, about 2" or 3" long, and 3/4" in diameter, open at one end and closed at the other. Into the open end a small piston or plunger is fitted, also of bone or bamboo. It is fastened on one end of a rod, at the other end of which is a knob. On the plunger end is a small piece of dried tinder. The plunger is inserted, the knob struck sharply to drive the piston down in, and the piston assembly then quickly withdrawn and the tinder will be found to have lighted. It may need to be blown very gently to fan the glowing tinder into a flame.

I tried to make one. Using the best (?) available material substitutes, and obtaining a close enough fit between the cylinder and the piston so that I actually exploded one model in which boiler glass was substituted for bamboo for the cylinder, I was totally unsuccessful in getting any signs of light at all. Then I discovered that the natives drill a small hole in the closed end the cylinder over which they place a finger in the down stroke, removing it before withdrawing the plunger. This allows fresh oxygen to enter as the piston assembly is withdrawn; thus the flame is not starved of oxygen and extinguished. But still I could not get one to work – and never have!

Reports on these things have been received in Europe for years. The fire-piston the natives make always seem to work easily. This is curious, because they have no idea why they get a light, they only know that they can. Whereas I can explain why the light occurs – but I can never get one!

These pistons were introduced into Europe, especially into France, in the 18th century, having been brought in by 'astonished travellers' as Henry Balfour says in his Paper on the subject.[1] They came from Malay, Sumatra, Java, Borneo, and the Islands of Luzon and Mindanao. He speaks of how the natives "nonchalantly take out a small piston, use it in an instant to light a cigarette, and replace it in their pocket."

The cylinder of these samples received in Europe was often wound with cord to stand the sudden compression, much as cannons were with wire. Subsequently copies were made and used in laboratories in Europe to obtain a light, or for fun. Balfour does not believe it possible, judging by their extensive distribution in the Far East, that the natives

borrowed the idea from Europeans. But in the meantime, interest had been aroused as to the cause of the ignition, and in due course, after some years, and stimulated further by some observations of related phenomena, Diesel and Robinson independently sought to design an internal combustion engine in which the compressed gas in the cylinder would be ignited by the same method, without the aid of any supplied electric spark. In reading the historical background of Diesel engines, one is seldom made aware of this anticipation by primitive people of the principle involved. In some cases, the story is told in such a way that the possibility of any such influence is not merely ignored – but actually denied. Lord Raglan feels this is unwarranted. He says:[2]

> This device has a wide distribution in South-eastern Asia, and must one would think have often been seen by European sailors and traders in those parts. Yet we are asked to believe that no European had ever seen or heard of it before it was "invented" by a Frenchman at the beginning of the nineteenth century.

The truth of the matter remains to be determined by further research. For the present it serves as a beautiful illustration of the motivating force in Europe as opposed to the native view of what is worth spending time on. Our curiosity enabled us, with technical support, to carry the invention to a level of usefulness of which the native never dreamed. One wonders whether we would have thought up the idea of an internal combustion engine with no supplied ignition system if we had never been shown a Fire-piston.

Another somewhat analogous case is that of porcelain. In this connection A. L. Kroeber says this:[3]

> It was the desire to avoid the expense of importation that led to the experimentation that finally produced the desired product [in Europe]. The consequence is that we have here what from one angle is nothing less than an invention. Superficially it is a "parallel" in the technical language of ethnology. However, it is equally significant that the invention, although original so far as Europeans were concerned, was not really independent. A goal or objective was set by something previously existing in another culture: the originality was limited to achieving the mechanisms by which this goal could be attained. If it were not for the pre-existence of Chinese porcelain, and the fact of its having reached Europe there is no reason to believe that Europeans would have invented porcelain in the 18th century, and perhaps not until much later, if at all.

But it seems that quite apart from such practical research, there exists in a surprisingly large proportion of Indo-Europeans a desire for understanding for its own sake. In fact, this feeling goes back a long way and actually accounts for the halting of further technological advances at one critical point in history. Farrington says:[4]

> There is room for doubt that the Ptolemies who financed the great scientific effort of Alexandria were interested in the practical application of its result... But a feeling was prevalent among the Greeks that Science ought to be useless.

Plutarch, writing about 100 A.D., in spite of some expressed regrets that mechanics was being expelled from the company of the liberal arts, yet goes on to praise Archimedes for his lofty contempt (even to the extent of refusing to demonstrate certain theorems with diagrams) for practical achievement and for anything requiring manual labour. Although his engineering feats had won him a reputation for superhuman ingenuity, Plutarch tells how he still refused to leave behind him any treatise on mechanics or any art whatsoever that touched on the practical. The balance between practice and theory is a sensitive one, and it is hard to know at what point further theorizing should be discouraged and practice

should begin. It is a current problem in the education of science for while it seems such a waste of time to let a man live in a kind of Ivory Tower, yet it so frequently happens that out of such an atmosphere where reflection in isolation is possible and where such mulling over of things as prompted entirely by a curious mind is given freedom, there accrues to the world at large some unexpected practical gain. There are some courses in the University of Toronto in which the Professor will actually refuse to give an answer to a practical question! This happened during the War, when many practical problems required urgent attention – yet true to his convictions, the Professor held that such questions were premature at that stage of our course. Yet the answer was needed then – not some months later. But in principle I think he was perfectly right, though it was my own question he refused!

Henri Poincare says:[5]

> One has only to open one's eyes to see that the triumphs of Industry, which have enriched so many practical men, would never have seen the light of day if only these practical men had existed, and if they had not been preceded by disinterested fools who died poor, who never thought of the useful, and who were not guided by caprice.

But Technology is still essential and prior. The Greek venture as Farrington put it, "was not killed – it died":[6] it had reached the limit of possible expansion within the mold in which it was cast. No further progress could be made without experiment, and without the technical aids for measurement and observation. Because these were missing, development came to an end.

A slave class, which did all the manual labour, rendered such activities quite improper for a gentleman and a scholar. Experiment was discouraged because it was socially incorrect to use one's hands. It was not until very much later in history that trade gave rise to a technically proficient and prosperous Middle Class, thus changing the situation so that skilled labour became an honourable occupation. Then men began to feel that perhaps after all a gentleman could tinker a little – provided of course it was not for money but was only for the advancement of pure learning or for the amusement of the less well-born![7] Moreover, the fine instrumentation required for exact measurement was now possible – which it had not been before. Such was the background of the founding of the Royal Society.

As a matter of fact, the Society was pre-eminently an association not of scholars and learned men so much as of curious amateurs interested in experimenting for the fun of it and anxious to get their hands on the few pieces of experimental equipment then available for the first time. Yet it must also be said that many of its charter members were also deeply interested in problems of industry and commerce.[8] Moreover it is clear that mere experiment for fun would hardly be likely to yield many useful results. As Iago Galdston put it:[9]

> Endless accumulation of observations leads nowhere. It is only when these observations are integrated by ideas yielding scientific generalizations and principles that they effectively advance Science ...
>
> It involves more than the extraction of a general principle by the process of summating so many old and newly acquired facts. It involves rather the formulation of questions to be answered by the process of experimentation. But the questions are not of an elementary character, and the experiment involves

> patterns not ordinarily found in Nature. Research then aims not so much at uncovering the ways of Nature *as to force nature to yield up her secrets.*

Now this is something that other peoples have been loath to do. They do not dare, or care, to tamper with Nature because it is personal, any more than we do with people so long as we believe that people are persons and not merely things. One enters into communion with an individual if one is concerned with understanding his motivations, and in the same spirit all non-Indo-Europeans seem to have sought to enter into communion with Nature in order to understand her 'motivations.' Only by such methods did they believe it possible to gain some measure of security – and (by the persuasion of magic) a small controlling interest. To them, Nature was *un*-predictable as people are unpredictable.

World Views

There has always been disagreement as to whether Magic is Science in the making. Some authorities hold that it is – usually because they have found to their surprise that the native is quite logical in his use of it, granted his initial beliefs. No native would waste good magic on poor soil, and often there are very exact rules surrounding the application of it which suggest that there is a rationale to it all in the minds of its practitioners. This is not always true, but it very often is. Besides, there was a certain element of good sound common sense in many cases. Samuel Kramer points out that the Sumerians believed firmly in the magic of incantation – but also advised one to do what one could to help. The Sumerian farmer, for example, was recommended to pray appropriately to the gods

of the soil to prosper the newly planted seeds – but he should also scare the birds away![10]

As Casssirer says:[11]

> What is characteristic of primitive life is not its logic but its general sentiment of life.... He does not ascribe to himself a unique and privileged place in nature.

This is what distinguishes Magic from Science, and sets the two virtually in opposition. To achieve the second, one must abandon the first entirely: and this means more than merely saying one does not believe in Magic any more – it means an entirely new view of Nature-Man relationships. The ***I-thou*** of Magic must give place to the ***me-it*** of Science. But granted this sense of kinship towards the world around, a kinship which is largely the basis of all forms of Totemism, the native then works as logically with his Magic as a man would who sought to persuade an acquaintance (whose friendliness is not completely established yet) to "change his mind."

In reviewing a book *African Worlds: Studies in the Cosmological Ideas and Social Values of African People*, edited by Daryll Ford, the reviewer John Middleton points out:[12]

> What may at first seem a jumble of superstition is ... seen to form a coherent set of beliefs. Once certain premises are accepted – including some denied by Western Scientific theory, then the entire structure built upon them is logical and reasonable.

I doubt whether there is any dissent among modern Anthropologists on this point, though there may be occasionally two mutually contradictory premises in some particular native thought system which introduce confusion (to our way of thinking) into the line of

reasoning. There is evidence, as Lévy-Bruhl showed clearly enough, that the "law of contradiction" is not always observed by primitive people. Yet they can rationalize their contradictory beliefs very often when pressed to do so. It is very essential to stress this point, because it is not a question of intelligence at all.

There are several reasons for the absence of Science (and Philosophy) among non-Indo-Europeans, but none of them as far as I can discover, has anything to do with the absence of the power to think logically. As we have seen, two reasons in particular which may possibly be related, are worthy of further consideration. The first is this all-pervasive sense of kinship with Nature, a world-view in which things do not have characteristics but *characters*. And the second is a language which is so specific that it does not permit the abstraction of generalities.

Let me explain the latter a little more fully first. The former reason will be dealt with in the next Chapter. I think I can do this most readily by using two quotations and then commenting on them.

E. B. Tylor, one of the founding fathers of Anthropology, says this:[13]

> Abstraction is noticing what several thoughts (or situations) have in common *and neglecting their differences*; thus a general idea is obtained by *not attending too closely to particulars*. [Emphasis mine]

And Max Muller, one of the founding fathers of Linguistics says this:[14]

> An empirical acquaintance with the facts rises to a scientific knowledge of the facts as soon as the mind discovers beneath multiplicity of single productions, the unity of an organic system.

And then an illustration: Newton discovered the concept of gravitation and its laws by taking into account three groups of phenomena which are entirely unrelated to the merely perceptive observer: freely falling objects, the movements of the planets, and the alternation of the tides.

Now in a sense non-Indo-Europeans *do* see the "unity of an organic system" of which Muller speaks, but it is not through observation of the common elements achieved by neglect of the particulars, but rather by a transfer of ideas, in which the social life of man is attributed to Nature, and the whole Universe becomes a single integrated Society – a Giant State – in which man is a very little frog. Because human nature is so unpredictable, they tended to note changes in human activity and to ignore the uniformities, and accordingly to notice the exceptions in Nature also, and to forget – or ignore – the regularities, at least to take little interest in them. Regularities of behaviour are safe, and one does not need to worry too much about them. It is the irregularities that one must take steps to insure against. One has to do this, if one's life is not too secure. "The Boss is in a good mood today" brings as much comfort to the office gang as favourable weather did to the non-Indo-European and noting the fact was important for everyone's well being. As soon as the exceptional occurred it had to be evaluated. Frequently it was frightening. Usually appropriate action had to be taken to deal with it. What to us is an interesting phenomenon, to them was a dangerous Omen. The secret was to cajole or persuade or scare or even cheat Mother Nature to change her mood and behave normally again, i.e., peaceably. You can fool people, so you can fool Nature too, if you know how. Thus

arises Magic. It is a gentle or forceful reminder to Nature to fulfil her obligations. It may seem silly to us. But it is not unusual to find oneself kicking a chair that has 'got in the way,' or getting angry with a motor that 'refuses' to start. The extent to which this animistic spirit is found even among College Students today is quite surprising. It has been reported upon recently.[15]

But to return to the observation of what is common rather than what is exceptional, it is in this capacity that man becomes a 'species maker,' and begins the formation of classes of things. Such classifications are the first step towards the creation of abstract concepts. But non-Indo-Europeans have not tended to form them, either because their languages do not have the terms for classes of things and they thus lack words to convey or inspire thoughts of this nature, or because for some reason their minds do not tend to observe these relationships. In the latter instance, they would not invent words for classes of things. In either case, their language should reflect the absence of categorizing tendencies, and this appears to be so.

Moreover, to observe what is common in several situations when only one situation is present to the observer at the moment, requires a certain kind of total awareness, an escape from the present and a consciousness of other events not now related to the immediate situation. Only thus can general laws be recognized. For example, a bullet fired horizontally, no matter what the muzzle velocity of the gun may be, will theoretically reach the ground at exactly the same time that a bullet merely dropped from the muzzle does. This law is an ideal one, and is seldom if ever realized in fact due to other

considerations. But the point is that only a special kind of mind would even think about it, let alone anticipate the fact. Certainly it is not obvious in the sense that one could assume it without giving much thought to the matter. The fact is there, but it is not obvious, and it could probably never be 'observed' in actuality.

William Whewell, in a classic work on the inductive nature of Science, seeks to make it very clear that there is more to the discovery of scientific laws than merely the recognition of existing facts. The relationships are what count, and in a sense these relationships do not exist. They are mental creations, although when once discovered they thenceforth may appear to be self-evident. Whewell says:[16]

> Induction is familiarly spoken of as the process by which we collect a general proposition from a number of particular cases; and it appears to be frequently imagined that the general proposition results from a mere juxtaposition of the cases, or at most, from merely conjoining and extending them. But if we consider the process more closely, we shall perceive that this is an inadequate account of the matter.
>
> The particular facts are not merely brought together, but there is a new element added to the combination by the very act of thought by which they are combined. There is a conception of the mind introduced in the general proposition, which did not exist in any of the observed facts. When the Greeks, after long observation of the motions of the planets saw that these motions might be rightly considered as produced by the motion of one wheel revolving inside of another wheel, these wheels were creations of their minds, added to the facts which they perceived by sense. And even if the wheels were no longer supposed to be material, and were reduced to mere geometrical spheres and circles, they were not the less products of the mind alone – something additional to the facts observed. The facts are known, but they are insulated and unconnected, till the discoverer supplies from his own stores a principle of connection. The pearls are there, but they will not hang together till someone provides the string.

And speaking subsequently of the relationships between Technology (which he, like older writers, terms Art) and Science, Whewell says:

> Thus Art in its earlier stages at least, is widely different from Science, independent of it, and anterior to it. At a later period, no doubt, Art may borrow aid from Science; and the discoveries of the philosopher may be of great value to the manufacturer or the artizan. But even then, this application forms no essential part of Science; the interest which belongs to it is not an intellectual interest.

The one activity is a search for solutions to practical problems, the other for solutions to intellectual ones. The first result in the invention of devices and techniques, the second in the invention of theories. Theories are related to the ideal, while techniques are tied to the actual. The former are often contrary to experienced fact, and in this sense are deceptions. The idealized theories of little boys are called 'lies,' but of men, they are the stuff of science. Curiously enough it is more characteristic of the Indo-European to tell lies than it is of the non-Indo-European, in spite of popular opinion to the contrary. In fact, A. Irving Hallowell says that the American Indians did not even have a 'category of fiction' as he calls it.[17] They had stories that we believe are contrary to fact, and therefore in this sense 'fictional,' but they believe them to be history – or they believed that they were *essentially* true. They did not invent stories to amuse their listeners. And this is equally true apparently of the people of the early Middle Eastern Cultures. As Frankfort says in his Introduction to *The Intellectual Adventure of Ancient Man*:[18]

> In telling such myths (as the Sumerians, Babylonians and Egyptians had) the ancients did not intend to provide entertainment. Neither did they seek, in a detached way and without ulterior motives, for intelligible explanations of the natural phenomena. They were recounting events in which they were involved to the very extent of their existence.

This is an important point, for it is their involvement with the situation which excludes objectivity and makes it virtually impossible for the non-Indo-European (unless influenced by Western Culture) to stand aside and see the relation which exists between what is present and what is not.

Harry Hoijer points out that the Hopi, a pueblo people of the south-west, cannot tell certain kinds of 'lies', their language simply does not permit it. Thus they may speak of 10 men but not of 10 days,[19] because you can have 10 men at one time, but only ONE day at a time! They may speak therefore of a time 'after the tenth day' if necessary, and so forth, but not of ten days. There are other reasons why they do not speak of 10 days, one of which is that strictly speaking they do not speak of one day either – in the sense that we do. Intervals of time do not exist in the kind of discrete way they do for us. Such a view of time becomes complicated, for living entirely in the 'now' all the time eliminates the future tense also. Thus a man has either done something or is doing it – he cannot, strictly speaking, say that he *will* be doing it in the future. If he has planned it sufficiently to be able to say this, he has already begun to do it now. So the future becomes the present; what he will be doing becomes what he is doing now. In fact, even in English we may speak in the same manner, as for example when we say "I am going shopping tomorrow with a friend," where we should perhaps more properly say "I shall be going shopping tomorrow, etc."

There is a wonderful illustration of this way of looking at time, in a story told by Melvin Kyle:[20]

> A desert traveller went with a missionary friend to visit one of the 10,000 mud villages in the Nile Valley. The night was not a restful one in a native home. The next morning the traveller wished to return as soon as possible to the boat on the Nile. The missionary however, knowing the demands of courtesy, insisted that they must not go until after breakfast, but expressed the hope that breakfast might be expedited. "Oh", said the host, "breakfast is just ready."
>
> One hour and an half after that time by the traveller's watch, a match was struck to kindle the fire to cook the breakfast. And some time later still, a cow was driven into the court of the house to be milked to provide the milk to cook the rice to make breakfast.

Was the host untruthful? Not at all; he did not reckon by time but by events. He had no way of determining the passage of time. When he said "Breakfast is just ready," he meant it was the next thing in the household economy, that they would do nothing else until that thing was done, and that everything done was to that end. He reckoned only by events.

Benjamin Lee Whorf states that the same is exactly true of Hopi thinking. The native who is planning to hoe his garden tomorrow is doing it today – by having planned it. Today and tomorrow are the same thing, in intent.

Hebrew has no distinct future form either. The tense of all verbs is either present or past (perfect), a thing either being done already, or being done now. For human activity the Present Tense is made to take the place of the Future, as though it was not possible to think of action as actually being done in the future... it is in fact a fiction. But not so with Divine Activity. Future action is so certain where God is the Doer, that it can safely be said to have now been done, and so the Perfect Tense is used. Hebraists refer to this as the Prophetic Perfect.

Languages

Thus the grammar of language in such instances determines the patterns of thought for the growing child. To some extent he does not 'think' lies of this kind, and cannot deliberately tell them. Yet as we have seen, speaking of what is contrary to fact is basic to all forms of theorizing. Negative numbers are completely fictional – though being in debt is real enough! Practically every scientific law involves some fictional element since it is always stated as true 'ideally', or 'in a perfect vacuum', and so forth. As Else Frenkel-Brunswik put it,[21] "It is precisely the fictitious concepts rather than those fully definable by observables that enable science to proceed to explanation and prediction."

Our own language structures our thoughts also: and although we assume it is expressing for us an actual and objective view of reality, the assumption might not be true. It seems as though it must be, since it has given us such wonderful powers of prediction. Yet there are people of other languages, and men of learning, who suggest the need for caution here.

Benjamin L. Whorf has made this observation:[22]

> We cut up and organize the spread and flow of events as we do, largely because, through our mother tongue, we are parties to an agreement to do so, not because nature itself is segmented in exactly that way for all to see. Languages differ not only in how they build their sentences but in how they break down nature to secure the elements to put in these sentences.... As goes our segmentation of the face of nature, so goes our physics of the cosmos.

On the other hand there are Chinese scholars, well acquainted with the Western tradition, who hold that it is a mistake to suppose this is any more than a provisional

analysis of reality. It needs correctives, the kind of correctives which may be supplied by the world-view in terms of other types of language. One supposes that if Chinese were to become the universal language, a very real possibility considering their population growth (though we tend to assume meanwhile that English will be!), we would in time accept a quite different world-view.

The efforts made by some groups to produce an inter-lingua might in the end, if they were extremely successful, impoverish the world beyond measure. In an article touching on this particular question, Alexander Gode quotes Benjamin Whorf as having said:[23]

> I believe that those who envision a future world speaking only one tongue, whether English, German, Russian, or any other, hold a misguided ideal and would do the evolution of the human mind a great disservice. Western Culture has made, through language, a provisional analysis of reality and, without correctives, holds resolutely to that analysis as final. The only correctives lie in all these other tongues which by aeons of independent evolution have arrived at different, but equally logical, provisional analysis.

And in a recent book which collects a number of miscellaneous Papers by the same writer, there is this statement which is relevant here:[24]

> Actually, thinking is most mysterious, and by far the greatest light upon it that we have is through the study of language. The study shows that the forms of a person's thought are controlled by inexorable laws of pattern of which he is unconscious. These patterns are the unperceived intricate systematizations of his own language.... His thinking itself is in a language, in English, in Sanskrit, in Chinese. And every language is a vast pattern-system, different from others, in which are culturally ordained the forms and categories by which the person not only communicates but also analyzes nature, notices or neglects types of relationship and phenomena, channels his reasoning, and builds the house of his consciousness.

But as Whorf says – "thinking in a language" does not necessarily mean the use of spoken words. That is to say one need not give *vocal* expression yet the thought is carried nevertheless in terms of language. This is clearly seen for instance in the case of Helen Keller who will walk up and down in times of stress (such as in the preparation of a 'speech') talking to herself with her fingers! Helen Keller's teacher, Miss Anne Sullivan, makes a strong point of this. She says, "The ordinary man will never rid himself of the fallacy that words obey thought, that one thinks and phrases afterwards."[25]

We have referred to the absence of abstract terms in non-Indo-European languages, and their abundance in both Sanskrit and the European languages.

The specificity of non-Indo-European languages has long been a constant source of surprise to the Westerner who meets it for the first time. It must determine their thought processes. If it does, it certainly prevents them from abstraction of the common elements in many situations. Even so, it is conceivable that their non-abstract world-view could be a perfectly valid one.

A modern Chinese philosopher, Chang Tung-San, was quoted as having said recently:[26]

> Take Aristotelian logic, for example, which is evidently based on Greek grammar. The differences between Latin, French, English and German grammatical forms do not result in any difference between Aristotelian logic and their respective rules of reasoning, because they belong to the same Indo-European linguistic family. Should this logic be applied to Chinese thought, however, it will prove inappropriate. This fact shows that Aristotelian logic is based on the Western system of language. Therefore we should not follow Western logicians in taking for granted that their logic is the Universal rule in human reasoning.

H. M. Tomlinson put it very appropriately when he said, "we see things not as they are, but as WE are."[27]

I am not acquainted with more than a few Middle-East languages – and this only to the extent of having spent some years in the formal study of them. But I never learned to think in them – an essential if one is to claim to have in any sense mastered a language. Some of those studied were, however, non-Indo-European, including Hebrew, Aramaic, and two in the Cuneiform Group. One is therefore forced to depend largely upon the conclusions of others in this area. However, there is no lack of authority for the statement that Sumerian, Egyptian, Chinese, and some at least of the Semitic languages show a marked specificity and a lack of words for generalized concepts.

Thus Cassirer describes many of the languages of the American Indians, pointing out that they have,[28]

> ... an astounding variety of terms for particular actions, for instance for walking or striking. [Striking] a blow with the fist cannot be described with the same term as a blow with the palm, and a blow with a weapon requires another name than one with a whip or a rod. In his description of the Bakairi language, one idiom spoken by an Indian tribe in Central Brazil, Karl von den Steinen relates that each species of parrot and palm tree has its individual name, whereas there exists no name to express the genus 'parrot' or 'palm.' "The Bakairi," he asserts, "attach themselves, so much to the numerous particular notions that they take no interest in the common characteristics. They are choked in the abundance of the material and cannot manage it economically. They have only small coin, but in this they must be said to be excessively rich rather than poor."
>
> In primitive civilizations the interest in the concrete and particular aspects of things necessarily prevails.... An interest in mere 'universals' is neither possible nor necessary in an Indian tribe.
>
> It is enough, and it is more important, to distinguish objects by certain visible and palpable characteristics. In many languages a round thing cannot be treated in the same way as a square or oblong thing, for they belong to different

> genders.... In languages like the Bantu family, we find no less than twenty gender classes of nouns. In languages of aboriginal American tribes, as for instance the Algonquian, some objects belong to an animate gender, others to an inanimate gender.
>
> The same slow process from concrete to abstract names can also be studied in the denomination of the qualities of things. In many language we find an abundance of colour names. Each individual shade of a given colour has its special name, whereas our general terms – blue, green, red, and so on – are missing. Colour names vary according to the nature of the objects: one word for grey for example may be used in speaking of wool or geese, another of horses, another of cattle, and still another in speaking of the hair of men and certain other animals.

Different numerals are used in connection with different classes of objects. Hammer-Purgstall, according to Cassirer,[29] has written a paper in which he enumerates the various names for the Camel in Arabic. There are no less than five to six thousand terms used in describing a camel; yet none of these gives us a general biological concept. All express concrete details concerning the shape, the size, the colour, the age, and the gait of the animal. In Hebrew the same phenomenon often occurs, as in Job 4:10, 11 where the English has the word 'lion' five times, but the original Hebrew uses a different word every time! The old lion, the young lion, the roaring lion, and so forth, are not the same thing at all....

In the new enlarged edition of H. G. Well's *Outline of History*, brought up to date by Raymond Postgate, there is a useful statement respecting the difference between the Chinese language, and the English, for example. Thus, speaking broadly of South-eastern Asia where there is a group of related languages including Chinese, Burmese, Siamese, and Tibetan, this statement is made:[30]

> The difference between any of these Chinese tongues and more Western languages is profound.... The relation of words to each other is expressed by quite different methods from the Aryan methods. Chinese grammar is a thing different in nature from English grammar; it is a separate and different invention. Many writers declare there is no Chinese grammar at all, and that is true if we mean by grammar anything in the European sense of inflections and concords. Consequently any such thing as a literal translation from Chinese into English is an impossibility. The very method of the thought is different.
>
> Their philosophy remains still largely a sealed book to the European on this account, and *vice versa*, because of the different nature of the expressions. We may give an illustration of this profound difference in method. The four Chinese characters indicating "affairs," "query," "imperative," and "old," placed in that order for example, represent the sentence "Why walk in the ancient ways?" The Chinaman thus gives the bare cores of his meaning: the Englishman gets to the sense by bold metaphor.

This quotation underscores, I think, the observation made by Multhauf in his review of Joseph Needham's work.

The difference in grammar and philosophy of non-IndoEuropean languages has been illustrated very forcibly by Lévy-Bruhl. Without indicating the exact reference by page number, the following is a summary of his chapter on "The Mentality of Primitives in Relation to the Languages They Speak."[31]

The Klamath language, which may be taken to represent a large family of languages in Northern Australia shows a well marked tendency to delineate pictorially what it is desired to express. Thus a motion performed in a straight line is referred to differently from a motion performed sideways or obliquely or at a distance from the one speaking, circumstances which it would seldom occur to us to incorporate into the verbal form.

In the language of the Yahgans, there are 10,000 words, the number of which is considerably increased by the use of prefixes and suffixes to indicate where one comes

from or is going to, either north, south, east or west, and from above, below, outside or inside. According to one of the best authorities on the Yahgan of Terra del Fuegia, T. Bridges, these differences are almost inexhaustible. That is to say, they are not limited merely to the points of the compass, but are influenced also by other circumstances surrounding the coming or going of the individual referred to, such for example as the time of the day.

At the other end of the world in South Africa, Livingstone found that verbs possessed the same power of expressing delicate shades of meaning. He is quoted as having said that it was not the want, but the superabundance of names that misled travellers. The terms used are so multifarious that even a good scholar will at times scarcely be able to catch anything more than the general tenor of the conversation. A score of words will be used to indicate different varieties of gait. One may walk leaning forward or backwards, or swaying from side to side, loungingly or smartly, staggeringly, swinging the arms or only one arm, head up or down or some other way. For each of these modes of walking there is a particular verb form, a clear indication that the people who use these forms of speech have overlooked what is common to the situation, i.e., 'walking,' and have been overcome by what is distinctive in each situation.

As Lévy-Bruhl says, from these and many similar facts it is clear that the languages of primitive people express their ideas of things and actions in the precise fashion in which these are presented to the eye or the ear. They have a common tendency to describe, not the impression which the subject receives, but the shape and contour, the position and

movement, the way of acting of objects in space – in a word, all that can be immediately perceived and delineated. They try to unite the graphic and plastic elements of that which they desire to express, namely, the unique in each situation.

The Bantu native, for example, will scarcely ever be heard to use a vague expression such as "he has lost an eye." But having noticed which eye it was, and pointing to one of his own, he will say, "This is the eye he has lost!"

Lévy-Bruhl quotes one authority as saying that while it is our aim to speak clearly and precisely, the American Indian's aim is to speak descriptively. We classify, he individualizes. For instance, the Delaware word *nadholineen* is composed of *nad*, a derivative of the verb 'to speak,' of *hol*, a boat: and *ineen*, which is the verbal termination for the first person plural. It means 'find the boat for us.' It is the imperative of a verb expressing 'I am finding the boat for you, him, etc.,' which is conjugated like any other verb but always signifies "find the boat" and expresses a particular act having no general meaning at all. It does not mean 'find any boat.' This is quite otherwise in Indo-European languages. The Latin *aedificio* does not mean 'I build a special edifice.' It means simply a liberated concept free of all attachment to any special situation, simply 'I build.'

Again, while it cannot be denied that those who speak these languages have a concept of hand or foot, etc., yet their concepts do not resemble ours. The hand or foot they imagine is always the hand or foot of the particular person whose hand or foot it is, and who must be delineated at the same time. In many Indian languages of North America there is no distinct word for eye, hand, arm, or any other parts or organs of the body. If

an Indian were to find an arm that had fallen from an operating table, he would say, 'I have found his arm.' The Bakairi of Brazil do not say 'tongue,' but always add a pronominal adjective, 'my tongue', 'your tongue', etc. Similarly in the Marshall Archipelago there is no generic word for 'father', the word never being used except in conjunction and applied to a particular person. The concept 'father' unattached, simply does not exist. This has been found to be true in the north-eastern provinces of India, and even when the possessive form of the sentence rendered the attachment of a pronoun unnecessary, the tendency to specialization was so strong that it would still be added.

Lévy-Bruhl points out that this is a very common feature in primitive societies and helps us to understand how it is that we find such complicated degrees of relationship between peoples and possessions. The European tries to conceive of these and rationalize them in the abstract, but the native never envisages them in this way.

In Australia there are no generic terms such as tree, fish, bird, etc., although specific words are applied to every variety of tree, fish, or bird. The Tasmanians had no words to represent abstract ideas and though they could denote by name every variety of gum tree or bush, they had no word for 'tree.'

In the Bismark Archipelago, there are no names for colours. Colour is always indicated by comparing two objects together.

The South American Indian has particular names for every type of monkey and palm and such objects as interest them. But it is in vain to seek among them words for the

abstract idea of 'plant' as opposed to 'animal.' In California, the natives have a separate name for every oak, pine, or grass, but no word for oak, pine or grass as a species.

The Australian aborigines have names for almost every minute portion of the human body, but in asking for the arm, the stranger would get the name for the upper arm, another for the lower arm, another for the right arm and another for the left. In this English sentence the word 'arm' occurs four times and once by implication. It would not occur more than once in Australian, if it occurred at all.

Turning to the north, the Lapps have a great many terms to denote various kinds of reindeer according to their age. There are twenty words for ice, eleven words for cold, and forty-one words for snow in all its forms!

In Southern Australia every range of mountains has its name and every hill in the range, so that the black man can state the precise mountain or hill in an extensive range. They have names for all the conspicuous stars, for every feature of the ground, every swamp and every bend of a river, but no word for 'star' or 'hill' or 'river.'

In all these cases the conclusion that one must draw seems to be the same. These people are intensely aware of the individual, the unique, the specific: but they have not abstracted the general. They have not classified objects nor categorized experience. Everything known and experienced is concrete, isolated, uniquely individual. Moreover, it is a general rule that the more intense their interest, the more profuse their vocabulary. Thus the Aymara Indians of Peru, to whom the potato is of great importance, have over 209 words for it!

Miriam Chapin[32] states that in one of the Australian dialects (the Kamilaroi) there are a dozen words for kinds of snakes but none for 'snake' as a concept. In fact you just cannot ask a man if he has seen a snake. You have to ask him if he saw a Nurai or black snake, or a Kaleboi or brown snake - and trust that if it was a green snake he will think it interesting enough to mention the fact. Moreover, one could not actually ask about *a* snake at all, it would have to be ***THE*** snake - i.e., the one you are asking about!

From all this it is clear that at least in so far as primitive non-Indo-European languages are concerned word-forms are a barrier to the development of the kind of mental constructs essential to scientific thinking. We may be permitted to draw the conclusion perhaps that since the high civilizations of non-Indo-European origin also took this same view of Nature and stopped there, that their languages were similarly structured and a barrier to further development. This seems certainly to have been the case with the high Middle American Cultures whose languages are still preserved in large measure in Mexico and in the Peruvian highlands. At any rate, of all the Middle East civilizations one generalization can be made, namely that they did not categorize. On this point, Farrington has said:[33]

> It may be remarked... that we have as yet no proof, in all this evidence from technique, of the attempt to organize even a particular branch of knowledge in a scientific way. The technical achievement itself is not proof of the power of conscious abstraction, of the capacity to detect general laws underlying the variety of phenomena and to utilize these general conceptions for the organization of knowledge.
>
> To put the point in another way, we have no evidence ... that they were attempting to classify ... that they were asking how one thing could apparently change into another, how bread for instance, which a man ate could turn into flesh

> and blood.... We have no certain proof ... of that kind of curiosity and that gift for speculation which are necessary for the creation of science in the full sense.

In this statement Farrington has in mind particularly the Egyptians, but because the tenour of his remarks shows that he was only using them as an illustration of the Middle East in general, I have taken the liberty of omitting their name in the quotation. In any case Frankfort follows Farrington in this view, and explicitly extends it to the Mesopotamian plains, as well as to the Hebrew people.

In the case of the American Indian and his differentiation by words between a man walking and a man running, it is clear that the Indian is noticing the distinct aspect of the situation, the walking as opposed to the running, not the fact that a man is involved in both instances. Because we notice what is common to the two situations, our sentence would contain (and does contain in the illustration above) the word 'man' as a common subject. In Cuneiform there is the same tendency to be concrete; for example, there are at least nine words which are completely different in form, for the word 'force' in Assyrian, which are to us readily replaced by the single word. We note the underlying concept of the word and make it apply to nine different situations at least, simply because these situations seem to us to have this concept in common. We speak of using force (physical), of a forceful personality (will), of the force of an argument (logic), of a force of men (number), and of the force of a play (its dramatic impact). And so on. An Assyrian would evidently not have made this 'mistake.' To him, this would have seemed hopelessly

confusing for evidently he would not have seen that there really was anything common in these concepts. Nor would a modern Hopi.

It is because words were so wedded specifically to situations that belief in word-magic arose. The word is the thing, the situation, the person. Names are people. It is not merely that people have names. This is the essential foundation of libel in a social context, and of blasphemy in a religious one. To change a name is literally to change the person, and in many unexpected ways this concept is found all over the world, even in a psychiatric ward in America where it cannot possibly have been 'learned' from someone else.[34]

According to Cassirer, Roman slaves had no name, because they were literally nonentities, a consideration which Roman law took into account.[35] In almost all primitive societies, a man's real name is known only to a few very close friends. A man goes by a nickname most of the time – a word, chosen by his fellows or himself, standing for the whole man in a unique situation. His real name is kept secret, for whoever can get hold of it, has obtained power over the possessor just by speaking it.

We have a number of pottery bowls which Egyptian kings of the Middle Kingdom had inscribed with the names of hostile tribes in Palestine, Libya, and Nubia, with the names of their rulers, and with the names of certain Egyptian rebels. These bowls were then smashed at a ritual in the express hope that, like the vessels, the owners of the names would similarly be destroyed.

This has been one of Cassirer's greatest concerns – the wedding of the word to the person or the thing, or even the whole situation. The bondage, at least among primitive people, he holds to be absolute. The attention is riveted to the immediate experience; the sensible present, as he puts it, is so great that everything else dwindles before it. A person whose apprehension is under this kind of 'spell,' is as though the rest of the world were annihilated. Any possibility of noting things in the present situation as being related or common to situations elsewhere experienced cannot possibly be recognized because the other situations no longer exist at all. So Cassirer says:[36]

> The ego is spending all its energy on this single object, lives in it, loses itself in it. Instead of widening of intuitive experience, we find here its extreme limitations; instead of expansion that would lead through greater and greater spheres of being, we have here an impulse toward concentration; instead of extensive distribution, intensive compression.

In such an attitude of mind there is no room for other relevancies, no energy for abstraction, no search for classes, no creation of generalizations, no perceiving of categories.

In some strange way, Indo-Europeans somehow *broke* this bondage, this "tyranny of words"[37] as it has been called. With us the word or sound or symbol stands *for* the object or situation, i.e., in place of it. It stands between us and the thing as a handle by which we can grasp it and manipulate it. We hold the situation, rather than being held by it. In other Cultures, the symbol was (or is) the thing. This is what largely accounts for the extraordinary profusion of signs and symbols in the lexicographies of all these high Cultures of non-Indo-European origin which developed writing. This applies to the

Sumerian cuneiform and its successors the Babylonian and Assyrian, to the Egyptian hieroglyphics, to the Hittite script, to the Chinese, quite possibly to the Indus Valley script, and similarly to that of the Mayas of Central America. They might simplify each character a little to save labour – but they did not reduce the number of signs, except perhaps where some sign was no longer used or required. In fact they became in China almost unmanageable by reason of their number, one estimate being around 25,000 to 30,000 ideographs.[38] None of these people reduced their signs to an alphabetical form, they could only go on adding or multiplying by combination.

It has been said that there is no 'spelling' in Chinese, and there was no 'spelling' in this sense in Cuneiform either. Such languages do not become vehicles of Philosophy or Science though they are quite adequate for Technology.

The Relationship

And so we come finally to the question of why this linguistic bifurcation of mankind exists. Is it genetically determined or merely culturally determined? Is there some feature of the actual brain structure that was acquired and inherited, in spite of current opinion to the contrary about the possibility of such things being inherited?

There has, for many years, been a recognition of the fact that mental illness can result in some strange forms of modified speech. Douglas G. Campbell and C. R. Congdon, psychiatrists in Chicago, some twenty years ago began a series of experiments to see whether some forms of mental illness might not in fact stem from 'ties' wrongly established

between words and things. According to one report, these experiments proved "astonishingly successful." By disconnecting such ties, the response of some patients was both sudden and dramatic.[39]

The extent to which such mental illnesses result from, or are reflected in, speech impediments is remarkable. On this point, Cassirer has this to say:[40]

> Recent research in the field of the psychopathology of language has led to the conclusion that the loss, or severe impairment of speech caused by brain injury is never an isolated phenomenon. Such a defect alters the whole character of human behaviour. Patients suffering from aphasia or other kindred diseases have not only lost the use of words but have undergone corresponding changes in personality. Such changes are scarcely observable in their outward behaviour ...
>
> But they are at a complete loss as soon as the solution of the problem requires any specific theoretical or reflective activity. They are no longer able to think in general concepts or categories. Having lost their grip on universals they stick to the immediate facts, to concrete situations. Such patients are unable to perform any task which can be executed only by means of a comprehension of the abstract.

Sometime later, Cassirer points out that in cases of aphasia it has often been found that patients had not only lost the use of special classes of words, but at the same time exhibited a curious deficiency in their general intellectual attitude. When such people were confronted with problems requiring the abstract mode of thinking, they often experienced great difficulty. They could no longer think of '*unreal* things.'

He illustrated this with the case of a patient suffering from hemiplegia, from a paralysis of the right hand, who could not utter the words "I can write with my right hand." He even refused to repeat these words when pronounced for him by the physician.[41]

Curiously enough there is a striking parallel instance of this strict attention to truth in the case of Laura Bridgman, a blind and deaf and dumb girl, somewhat in the same situation as Helen Keller.

One of her teachers, according to Cassirer, remarked it "was very difficult in the beginning to make her understand figures of speech, fables, or suppositious cases of any kind...." Her teacher then states that Laura Bridgman could not extract herself from problems in arithmetic proposed to her. If she had not actually bought two apples for five cents each, it simply did not 'cost her 10 cents,' and she rejected the hypothetical problem intended to teach her how to add! One question she rejected because she never drank the liquid (cider) involved in it. Now this does not mean that there was anything positively wrong with her brain. It indicates only that in a certain stage of underdevelopment, even an adult may find it impossible or very difficult to escape into the abstract and deal with hypothetical situation.

Now Goldstein and Gelb have done a lot of research in the field of brain surgery. After some operations they found that patients can no longer deal successfully with merely 'possible' situations. Speaking more particularly of lobotomized patients they report that such subjects are no longer capable of grasping what is abstract. They explain what they mean thus:[42]

> This demands the ability to live in two spheres, the concrete sphere where real things take place, and the non-concrete sphere – the merely "possible" one ... This the patient is unable to do. He can live and act only in the concrete sphere.

In a subsequent paper, Goldstein reinforces his statement about the loss of the power of abstraction in lobotomized subjects. He writes:[43]

> The assumption that lobotomized patients suffered no loss of mental capacity was based on their performance in conventional intelligence tests. Apparently the operation did not reduce their intelligence quotient. . . .
>
> [However] analysis has shown that the capacity to assume the abstract attitude, also known as the "conceptual" attitude, a prerequisite of normal human behaviour, acting voluntarily, taking the initiative, shifting voluntarily from one activity to another, making adequate choices, classifying objects or ideas, grasping the essentials of a complex situation, synthesizing new ideas, reacting correctly to objects or situations with which one is not directly concerned, detaching one's ego from the outer world, and reacting in an objectively correct manner ... it is exactly in the problems or tasks which require these abilities that we find patients with gross frontal lobe lesions defective. Indeed, such a patient may show some peculiarities even in concrete behaviour when the latter becomes dependent on abstract considerations.

Much work has been done in this area which has strongly tended to confirm the theory that the power of abstraction lies chiefly in the frontal lobes and that people who do not exercise this faculty are not using this area of the brain to any great extent. Confirmation of this assumption has come unexpectedly from Africa. A few years ago J. C. Carothers was asked to design a series of tests by which to determine the suitability of African natives applying for positions as assistants in the Medical Research Laboratory, Nairobi. These tests were to give some indication as to the dependability of the native in certain situations which could be expected to occur in the labs. Carothers made several discoveries in this undertaking, and published his conclusions in a paper entitled "The Frontal Lobe Functions and the African."[44]

He reported that "certain facts emerged which forced his attention to a striking resemblance between African thinking and that of leucotomized Europeans." This led him in due course to make certain deductions about the neurophysiological basis of African thinking and character and about the functions of the frontal lobes in general.

To begin with, he decided to see in what kind of situations the African native would "let one down."[45] A questionnaire was sent to three employers of Africans in considerable numbers, including natives of all levels of education and sophistication. The results were very interesting as shown by the sample illustrations Carothers gives. Particular note is made of the absence of any well developed power of abstraction. One specific failing was in not seeing an event as an element in a total situation and as having a variety of relevant relationships. Routine was continually followed unreasoningly.

For example, three native overseers were in charge of a game being played by number of mentally deficient patients. While the game was in progress, one of the patients ran away. All three native overseers took off after him, leaving those who remained entirely unattended. He also mentions a lack of interest and attention unless the situation appealed in a directly personal and *emotional* fashion.

On the other hand, their quickness to learn by hearing or sight is referred to with some surprise, and they have a remarkable ability to grasp, work out and create intricate relations in the auditory sphere. Carothers sums up this section of his paper with the observation, "The African is hardly in fact an individual in one sense of the word, but a series of reactions."[46]

The author then turns to a consideration of the Leucotomized European Personality. He notes the same general pattern af behaviour appearing in persons who were not known to have so behaved previously, and says for example :

> When the leucotomized patient shows a personality change at all, it is in the direction of *a failure to see* an event as an element in a total situation and as having a variety of relevant relationships.

Under the heading "Some Deductions," Carothers reports:

> Except in so far as the African's ritual training mitigates some of the more socially flagrant symptoms (e.g., rudeness, and tactlessness) and except that the African shows no lack of verbal ability or of phantasy, the resemblance of the leucotomized European patient to the primitive African is, in many cases, *complete*.

He also adds this little note of an interesting and rather surprising circumstance:

> It seems also not without significance that at least one of the few Europeans leucotomized in Kenya, has since his operation, consorted much more happily with Africans than with Europeans, in marked distinction from his previous behaviour and to the great embarrassment of his relatives.

His final conclusion is summed up as follows:[47]

> "It is considered, on the evidence of leucotomy in Europeans, that all the observed African peculiarities can be explained as due to a relative idleness of his frontal lobes."

It seems particularly desirable at this point to emphasize that there is no justification for supposing that the European abstractive mentality is superior. It is different, but it is not necessarily superior; for without the fruition in Technology, of the much less abstractive but more practical mentality, of the African (for example in the working of iron), Europeans would quite probably have created a society as physically impoverished as

India has been in the past. The emphasis must be on the *difference*, not on the superiority of one type of mind as opposed to the other. It may well be that the human mind is limited in such a way that, except on rare occasions, the frontal lobes inhibit some other part of man's mental faculties, and *vice versa*. Leucotomy in this case, merely undoes as it were, the cultural impress of European civilization. Furthermore, it has been demonstrated from tests given to soldiers with severe wounds, causing injury to the frontal lobes, that there is no apparent loss of intelligence as a result.[48] These tests were administered ten years after the injury, allowing plenty of time for the defect to become evident. Other kinds of tests however did show some decrement in intelligence where the tests involved the use of language, and certain kinds of brain injury had been sustained.

That one area of the brain might exercise some dominance over another is not strange. Experience teaches that too much reflection can confuse issues, both inhibiting action, and preventing insights. Sometimes one has to forget a problem entirely, in order to solve it. Shakespeare was quite justified in saying, "And thus the native hue of resolution, is sicklied o'er with the pale cast of thought," and it is common enough to find that some people act first and think afterwards, whereas those who think first often get no further than the thought. The division might well be, in a very general sense, between the doer and the thinker, even perhaps between the extrovert and the introvert. So strongly was Carothers convinced that this kind of bifurcation could be justified, that he wrote a further Paper on the subject which he titled "The African Mind, In Health and Disease: A Study in Ethnopsychiatry,"[49] which was published by the World Health

Organization, and was reviewed favourably in the *Journal of the Royal Institute of Public Health and Hygiene*.[50] Evidently he succeeds, in the reviewer's opinion, in sustaining the implication of his title which assumes the existence of something that may properly be called an African MIND, in spite of the admitted "diversity of tribes and races" on that Continent.

Walter Freeman and James Watts have similarly observed this relationship between the frontal lobes and behaviour, and they express the opinion that in some way foresight and insight are affected by the operation of frontal lobotomy.[51] They hold that, in the frontal lobes there resides the synthesising faculty, the ability to assume an attitude of insight into a total situation. When Europeans are operated on in this way, they seem to be able to conclude their thinking processes more quickly than a normal person, not taking time to "finish up" thought, as the authors put it. Consequently it is felt that the frontal lobes operate for the "consummation of thinking." Patients are "quite adequate at the concrete social level" but lack a certain attitude towards the future that is characteristic of the mature individual. They tend to be improvident, having little regret for the past or concern for the future. They live very much in the here and now. This is quite similar to the attitude towards life of primitive people as a whole, in whom there is otherwise no evidence of mental ill-health.

Ralph W. Gerard has done a great deal of experimental work in this area, especially with animals. He has taught white rats to run a maze and then subjected them to considerable surgery of the brain which apparently had little effect upon the power of

becomes very difficult: etc. He also notes the following, which is directly relevant to this thesis:[55]

> In other instances description has been made of substitution of the concrete and immediate, for the abstract or real meaning ... There is a tendency for thinking to be concerned with the factual rather than the abstract. Decisions are made along practical lines ... introspection no longer interests the patient.

I do not suggest that there is any more than a very tentative clue here. It could be that the adoption of a European language by a native would effectively change his awareness also. It seems, in fact, most probable. And it could be that a European by birth who had been brought up to speak no other language than some African dialect, would share their particular form of *awareness* and would thus appear to be not unlike the European leucotomized patient. There must surely be plenty of cases where this has happened which would go a long way towards settling whether the native thinks as he does because of a form of mental 'deficiency,' or merely because his thought patterns have been predetermined for him by the language he inherited as a child, and that he therefore has little or no need to use the frontal lobes.

Once such a pattern of thinking had been established in the childhood of any Culture and the language had become structured more or less firmly, this would guarantee the preservation to a large extent of the form of world-view.

Benjamin Lee Whorf puts the question this way:[56]

> How does such a network of language, culture, and behaviour come about historically? Which was first, the language patterns or the cultural norms? In the main they have grown up together constantly influencing each other. But in this Partnership, the nature of the language is the factor that limits free plasticity and

memory. He concludes that any part of the brain seems able to take over the duty of any other part, and as he puts it:[52]

> It remains sadly true that most of our present understanding of mind would remain as valid and useful, if, for all we knew, the cranium were stuffed with cotton wadding. In time the detailed correlation of psychic phenomena and neural processes will surely come, but today we are hardly beyond the stage of unequivocal evidence that the correlation does exist....

This caution is necessary, because there may be quite other reasons why pre-frontal lobotomy or leucotomy results in the kind of personality changes which have been noted. Moreover it is not essential to my thesis to establish this connection in any case. But certainly this is a remarkable parallelism between non-Indo-European thought patterns as reflected in their language, and those of leucotomized European patients.

As Gerard admits:[53]

> Halsted has found a striking defect, in patients whose frontal lobes have been partly removed, in the ability to make categories. A normal adult, given a miscellaneous collection of familiar objects and asked to group them in as many ways as possible, can set up dozens of categories for grouping, by colour, shape, material, and so on. The operated patient can make few if any groups.

Further evidence of the correctness of this association is given by Frank J. Otenasek[54], in an issue of the *Bulletin of the Isaac Ray Medical Library.* He warns that "reports on the results of lobotomy as found in the literature are confusing." But he feels that certain things can be stated with a fair degree of assurance. Two lobotomized patients will be more similar to each other after the operation than before: interest and initiative are reduced: lack of personal restraint (a kind of childishness) is evident: matters worthy of earnest attention are joked about instead: persistence is reduced and prolonged attention

rigidifies channels of development in the more autocratic way, This is because language is a system, not just an assemblage of norms.

CHAPTER IV.

SOME CONCLUSIONS RESPECTING THE PATTERN OF EDUCATION IN THE LIGHT OF THESE FINDINGS

If it could be demonstrated that there was a genetic foundation to this bifurcation of mankind along the lines of mental-imagery or what ever we may call such a kind of mental set, it would not be too difficult to account for its persistence in spite of the vicissitudes of history. The Mongol racial characteristics, for example, – black hair, dark brown eyes, comparative hairlessness, the epicanthic fold, etc. – have persisted, partly because some of them are dominant over the alternative characteristics. It seems likely that there must also be some relationship between bodily and mental characteristics. Sheldon has found a correlation between body type and temperament that is remarkably high.[1] His figures are challenged by some authorities, but they are based on a large sample – some 45,000 individuals.

Moreover, the existence of a kind of national character is now likely to be recognized more willingly since the concept of racial superiority has been pretty well buried. Some very sane and balanced scholars admit the objective reality of differences in mental set. Occasionally the modal personality may be traced to environmental influences, as in the case of the Aymara who are somewhat shorttempered, or in the case of residents in the tropics who may tend to be mentally and physically less active than those who live in a cool environment and are subjected to quite violent fluctuations in temperature from one

season to another.[2] These may be very transient responses to the environment, resulting from the basic flexibility of all living things.

But it is not altogether impossible that there is a real genetic foundation to the mental attitudes of whole societies, if they have maintained themselves 'racially' intact for a sufficient length of time to become genetically stable.

Laurence Snyder wrote in this connection:[3]

> Recent refinements of procedure, notably the twinfamily method, have provided important evidence for the genetic basis of specific disease entities, physical and mental, as well as of basically uniform patterns in the organization or disorganization of physical and mental capacities essential in effort tolerance, personality integration, and intellectual performance.

Edward Sapir goes further. While recognizing the dangers of holding such opinions, he nevertheless says:[4]

> There need be no special quarrel with this conception of a national genius so long as it is not worshipped as an irreducible psychological fetish ...
>
> Here, as so often, the precise knowledge of the scientist lags somewhat behind the more naive but more powerful insights of non-professional experience and impression. To deny to the genius of a people an ultimate psychological significance and to refer it to the specific historical development of that people, is not, after all is said and done, to analyze it out of existence ...
>
> The whole terrain through which we are now struggling is a hot-bed of subjectivism, a splendid field for the airing of national conceits. For all that, there are a large number of international agreements in opinion as to the salient cultural characteristics of various peoples. No one who has even superficially concerned himself with French Culture can have failed to be impressed by the qualities of clarity, lucid systematization, balance, care in choice of means, and good taste, that permeate so many aspects of the national civilization.

A. L. Kroeber[5] takes a somewhat similar view and is willing to concede the existence of recognizable differences in the national characteristics of the Spanish, the French, the Germans, the Russians, and the 'Americans.' But he feels that such differences result from Culture which he views as a kind of "social fact" (to use Durkheim's term), something reified which has almost an independent existence of its own apart from those who happen to live in it. This is a view of Culture about which there is considerable argument, but all agree that Culture is pretty compulsive of personality formation in many ways.

If there is such a thing as national character, there is probably something common also to groups of people who belong within the wider classification of 'stock' or 'race.' Speaking of this, from the point of view of the human geneticist, Curt Stern indicates not only the likely sharing of bodily characters, which is assented to readily enough, but also of mental traits. He writes:[6]

> Stressing possible genetic factors in racial mental differences does not deny some plasticity, and stressing plasticity leaves room for possible genotypic differences. Even lacking exact knowledge, one may still be rather confident not only of the existence of great plasticity, which is an obvious phenomenon, but also of genotypic differences in racial endowment. Mental traits are correlated with material physical factors among which the organization of the nervous system and the hormonal constitution are the most important.
>
> Delicate and far-reaching inter-relations may mold the psychology of each individual in conformity with all aspects of his physical make-up. Since genetic differences influence all parts of the body and since absolute and relative differences in allele frequencies have been established for various genes in different races, one may expect some genetic influence on mental traits. The important problem is how great this influence is in differentiating races mentally.

This is a somewhat involved statement, but it means in effect that there are good grounds for believing that a certain mental set can become common to a society or even to larger aggregates of people by inheritance genetically and not merely culturally.

Nevertheless, it seems likely that the cultural pressure is the deciding one because we know that the Oriental can enter into and achieve the spirit of the Occidental world-view; and there are not a few anthropologists who have in a real way mastered the spirit of an alien culture sufficiently to be able to feel towards Nature something of what the natives feel – thereby coming to understand their thinking processes to a large extent. This has *always* involved, it may be added, the mastery of the native language – at least to the point where thinking in it is possible.

That such 'conversions' can be achieved at all, by the process of re-education suggests that education itself has far more to do with the mental attitudes of a culture than heredity. The influence of language is implicit of course, almost if not quite unperceived by most of those who use it, but the influence of education is explicit and calculated to a large extent. In the most primitive of cultures, the 'course materials' both for boys and girls are clearly laid out, and graduation, i.e., initiation, is at all times recognized as the goal.

Education Leading To Technology

In order to clarify the influence of any single factor in a complex cultural situation, it is helpful sometimes to isolate the factor in its simplest form. Primitive forms of

education are simple and the objective understood by both master and pupil, namely the preservation of the status quo. Such objectives may differ from ours in many ways, but in spirit they stand for the same process, being the method by which a Culture seeks to guarantee its own continuance. The Cultural wealth in the form of beliefs, values, skills, and rights, are communicated to the next generation by the present one. For us this poses peculiar problems because our values and beliefs and even our rights, are in a state of flux, so that one generation with one set of values is seeking to indoctrinate a new generation with a slightly different set of values; often, in fact, with a value system that is passing away. This does not happen in a primitive society for a number of reasons which are worthy of consideration.

If we examine these Cultures where the struggle of the community to survive is severe because the environment has not yet been mastered sufficiently to give an adequate sense of security, we can probably obtain some picture of what must have been true in very early times when all societies were precarious in this sense, whether non-Indo-European or Indo-European.

Such primitive cultures are bound by tradition to an extraordinary degree, because having once found how to survive, the margin of survival being still very small, no changes dare be allowed for fear of disrupting the established balance of things. The feeling of community with Nature is very close. She must not be offended in any way, or the caribou will not come back to provide food and raiment next winter, and the rains will not come to fertilize the seed planted hopefully in the parched desert, and so forth.

The simplicity of a Culture bears upon the ingenuity of its solutions to the problems of getting food. Nature is sensitively balanced as we know only too well, and primitive people are aware of this, though they treat the word 'sensitively' in its psychological sense. A rabbit or a bird or a fish or a bear must be killed respectfully and cooked in the proper way. One does not cook certain forms of life together, simply because these forms of life are antagonistic in Nature. The Indians of North America were horrified at the first plows of iron used by the White Man. One should use wood which grows out of the earth, if one wishes to plow Mother Nature. Nor should a steel knife be used to cut fish – but only bone, because the fish are accustomed to having bone in their flesh. When killing certain types of animals, such as bears, one apologized especially if bears were scarce, so that the spirit of the bear would go away peaceably and return again in due time. The Naskapi Indians always had a threefold Blessing for food before eating it. "Thank you Creator for sending the Caribou, thank you Caribou for being obedient and coming, and thank you Cook for preparing it so well!"

This meant that one did not simply go out and kill animals. There was a wrong way and a right way, a dangerous way and a safe way. The safe and proper way must be taught to the rising generation. It usually involved a great deal of sound factual knowledge. The chains of cause and effect were more carefully noted than we are apt to suppose: but the interpretation was entirely different from ours. Yet it worked. When it was a matter of life and death, observation had to be keen and clear.

But another important consideration in this transfer of exact knowledge and skill, is the fact that there was no written record of it. This inevitably made the older members of the community the only 'knowing' or educated people. A young man could not short-circuit experience by reference to a handbook that at times might make him more knowing than his teacher. He had to learn the correct way to kill and prepare a bear or a bird, from an older man. And when learning is the preserve of the older members of the community, it is far more conservative, for only youth wants to change things all the time.

Besides, animals and people are related. One had to be careful not to kill a relative. Australian aborigines believe that at one time animals and men were kind of animal-men creatures. Then one day they were separated. Some men parted from a kind of ostrich-man, some from a rabbit-man, some from a walla-walla-man, and so forth. Thus each tribe has a totem or brother animal which is taboo as food, since it is a relative. Once a year however, a ceremonial Communion Feast is held in which the men dress up like their totem animal, and eat the flesh of that particular animal ceremonially. This united the tribe with its animal brothers, and momentarily restores the ancient days before the division existed.

These Feasts are very solemn occasions. All kinds of ritual are prescribed.The slightest error in recitation or dance step or body movement or table manners can be fatal, for the ostrich or the rabbit will be offended and will then warn all the other animals which are not taboo as food, and the plants too, of the unworthiness of the tribe to be permitted to continue. So there is much to learn, and it is learned only by rote – not by understand-

ing: and the movements and dances and costumes are learnt from the older men in secret and cannot be learned any other way.

The Australian is no exception in this, though better known because many of his traditional beliefs have survived into the present. But what is true of the aborigine in Australia is true of the Eskimo, and the American Indian, and the African native. And it appears to have been largely true of the Sumerian, and the Egyptian. Evidently a high culture and a greatly increased sense of security is not sufficient to disturb this view of Nature very much. This is probably because in one area of life, the supernatural, there is no security possible. We distinguish between the supernatural and the natural with a kind of precision that is totally beyond the native. To him, there is no such division. The contract between man and the world about him was always a contract between persons, though he himself was a very minor party in this agreement.

In Egypt, where annual records of the heights of the Nile were kept from the earliest times, the Pharaoh nevertheless made gifts to the Nile every year about the time it was due to rise. To these sacrifices, which were thrown into the river, a document was added. It stated, in the form of either an order or a contract, the Nile's obligations.

Such guarantees for the safety of the community were carried out only by the older men who knew how. There were no shortcuts for precocious children, any more than we would send an inexperienced youth on a very grave mission to some powerful Monarch. Nature was not considered as ***It***, but as ***Thou***, and the relations between men and Nature were personal not impersonal. The forces of Nature were more like Wills than forces, just

as the characteristics of things were Characters. One did not ask "What happened?" One asked "Who did it?" The kind of question determined the kind of search. Cause and effect were interpreted accordingly. Thus in the presence of any situation that demanded attention, the attitude of the individual was one of involvement. In exactly the same way that we cannot normally treat people as things (and doctors are therefore reluctant to operate on their relatives) in this same way these people could not stand in the presence of Nature as a 'thing.' The native lore of the American Indians has a real beauty to it: it is the beauty of long experience with life and it is not communicated quickly. Education in such a society is education in Wisdom, as well as in knowledge.

Moreover, in such a personal view, the concept of experimenting to 'find out' is akin to sacrilege. It seemed to the native rude and improper to tamper with things just to see what would happen. This feeling of impropriety prevented the Taoist philosophers from being scientifically curious about things.

The same was true of the Middle East. The concept of causality was quite different from the scientific one. As Frankfort put it:[7]

> Our view of causality would not satisfy primitive man because of the impersonal character of its explanations. It would not satisfy him, moreover, because of its generality. We understand phenomena, not by what makes them peculiar, but by what makes them manifestations of general laws. But a general law cannot do justice to the individual character of each event. And the individual character of each event is what early man experiences most strongly.

Events are not analyzed intellectually, they are experienced individually. Emotional involvement concentrates all attention on the detailed present and freedom for the

objective association of ideas in the past is virtually denied. Man becomes entangled in the immediacy of his perceptions. This attitude is viewed as the proper one. It is analogous to 'paying attention' and 'being respectful.' Such a precept was taught as fundamental to survival to every youngster about to become a man. It formed the basis of his search for a vision to guide him in the choice of an emblem or guardian spirit. He had to find some special 'power' in Nature with whom to establish specific relations as a kind of go-between, or mediator.

The sense of weakness in the face of the Wills of Nature is very marked, and continued apparently through the process of civilization until the Greeks challenged it. Among the Hebrews it was converted from 'superstition' to reverence, and awe: but the idea of tampering with Nature was still quite abhorrent. The world continued to be confronted not with detachment but as equally involved in the service and worship of God. Hence the strong element of animation in the Psalms. We may interpret this now as being one way of declaring the appropriateness of God's every created thing. But to the Hebrew it was something more than this probably.

In Babylonia and in Egypt, man in society accompanied the principle changes in nature with appropriate rituals, which were viewed not as merely symbolic, but as 'willed' counterparts, part and parcel, of the Cosmic events. Man *shared* in these events, just as the Hopi rainmaker shares in the making of rain. The same is clearly true of China. The festivals are but modern recollections of such ancient beliefs, though they have lost much of their meaning because of cultural changes induced by contacts with the West.

There is logic in much of what is done. The Hopi stamps his feet to wake up the earth so that it will be quite ready to receive the rain that heaven is about to give. Some things are more alive than others. Fire is particularly so. But then some animals are more alive than others, so it seems.

When a man makes an image of an enemy and commits this to the flames, he is asking the fire to judge between him and his foe. If the fire burns the image furiously, the fire has given a clear decision in his own favour. It would not occur to a native to ask whether perhaps the wood of the image was particularly dry, and therefore burnt quickly on that account, any more than the Azande would ask similar questions about his *benge*. The fire was asked to give a clear decision, and this decision was given. That settles the matter.

Frankfort summarizes this view so manifest in Mesopotamia and Egypt where culture was certainly not 'primitive' in the accepted sense, with these words:[8]

> The Universe did not, like ours, show a fundamental bipartition into animate and inanimate, living and dead, matter. Nor had it different levels of reality: anything that could be felt, experienced, or thought had thereby established its existence, was part of the cosmos. In the Mesopotamian Universe everything, whether living being, thing, or abstract concept – every stone, every tree, every notion – had a will and a character of its own.
>
> World order, the regularity and system observable in the Universe, could accordingly be conceived of in only one fashion: an order of wills. The Universe as an organized whole was a Society, a State.

In this State man was very powerless. Even animals had more power at times; and of course earthquakes, thunder and lightning, mighty floods, and eclipses, were overpowering in their wilful destruction and terrifying aspects. Such forces are not to be played with.

Thus it was important to be able to discern Nature's mood of the moment. One must always be on the lookout for evidences of enmity or disapproval in Nature. The slightest irregularity in events boded ill for the observer. It is no wonder therefore that the exception, not the rule, was the object of chief interest. Signs and omens ... not laws, were the centre of attention. Education was intended to render this awareness more acute.

Moreover, if one can cajole or persuade Nature to be friendly or merciful towards oneself, obviously one ought to be able to persuade Nature to be injurious to an enemy. So arises the use of both White and Black Magic, and the battle of 'lobbyists' in this giant Republic begins. Education becomes not merely a matter of learning to preserve the Cultural values and skills as such, but also learning to preserve oneself in a rather hostile environment, where conspiracy is rampant and where safety lies in knowing either the right people (spirits) or the right formulae. The exactness of one's response was all important. Errors could be fatal.

The more precarious the society, the more suspicious will it be of the exceptional or outstanding individual; and the less favourable will it be to innovations either in word or deed, on the part of one of its members. Such innovations can only have a secret and dangerous meaning. There is no room for the brilliant child, or for the individualist in the class.

All these considerations had a profound bearing on the problems of education. In the first place the whole emphasis was upon the survival of the community as a whole, and not upon the encouragement of the individual as such. Conformity was the watchword,

preservation of existing knowledge the goal. In a situation where the old men held the keys to knowledge, tradition and conservatism rule the day. Youth had no power to effect changes.

Furthermore, the older men would be jealous of the younger man who proved exceptionally gifted. Since the method of injuring one's enemies is by the use of magic, in which the old men are skilled and the young are not, a young man dare not risk running foul of a superior. Discretion rules the day and serves very nicely to discourage ambition before it can feed upon itself.

The main emphasis in all education of this sort, is upon memorization rather than upon creative mental activity. Children are taught to learn, not to think. Since a creative mind must create or cease to be creative, any who might have had new insights and new ideas were soon rendered mentally docile and inactive for lack of encouragement.

But this leads naturally to a consideration of 'inventions'. What happens when a man has a new idea – can he introduce it? The answer is Yes and No. He may introduce it if it does not conflict with an already existing pattern in the Society. Too much is involved, too many ramifications to permit much disturbance. It is analogous to the 'disappearance' of the occasional invention of, say, a new Carburetor, that cuts down gas consumption by 300%. The oil companies cannot allow this – so it is said. However the rejection of such an invention in our Culture is a completely rationalized and objective one. In other Cultures it may be an emotional one.

Let us say that an invention appears in such a Culture which does not conflict with existing patterns – and is accepted. Then what happens? Can it be improved upon? Again, the answer is Yes and No. Yes, by the originator: No, by any one else. To attempt to improve the invention is an insult to its inventor. It is analogous to adding a moustache to a friend's photograph to improve his appearance! We just don't do that kind of thing, even if we are sure it will improve his appearance, and sure that he will never see it again....

In the same way that every symbol is wedded to the 'thing' for which it stands and which called it forth, so every invention is wedded to the circumstance which called it into being. It cannot be used by transfer in some other application. It is just conceivable that wheels, for example, were used first for toys in the New World,[9] and that *for this reason* they were never subsequently applied to larger vehicles. It is however true also that they had no draft animals. Yet wheeled platforms could have been used for the moving of stones, etc., especially in view of their road systems.

At any rate, to divorce the invention from its inventor, or its original application, was not wise. This is not so strange really, for anyone in our Society with an inventive mind, will experience the same kind of feeling of identity with his invention, and will tend to resent its modification, unless the modification is initiated by himself. It seems like robbery otherwise.

Thus once the originator was dead, his spirit could be dangerously offended if his invention were in any way changed. So development, the evolution of civilization, was

restrained by such beliefs. On the other hand, a stranger could introduce a new idea, and it might be welcomed – if it did not conflict with other elements in the Culture. If the stranger then withdrew, his invention could be safely modified. His spirit was no longer around to make such activity dangerous. But again, if a native of the Culture radically modified the innovation, it could then come to be identified as *his* invention and thenceforth its modification was taboo.

It was also important, in this exchange of ideas, that the right kind of person sponsor the innovation at the beginning. A king who favoured some device of no value whatever, could 'stick' his people with it for the rest of their cultural history. Whereas an unpopular or despised member of a society who happened to be the first contact to introduce a new device would thereby cast a shadow over it so that it might never gain acceptance no matter how desirable it was intrinsically.

This is not only true of new devices – it is equally true of new *ideas*. As Robert Lowie says:[10]

> Training, accordingly, was not in the interests of expanding but of preserving knowledge: and if new observations ran palpably counter to the old they were not treasured but discarded. The conscious striving by trained workers to increase knowledge regardless of past convictions is unknown in primitive and early cultures.

In a primitive society the community largely takes precedence over the individual, and communities as such are not progressive. It is the individual who provides the motive power for revision of the status quo. It was Lebzelter who formulated the principle that small communities are variant in physical type but homogeneous in Culture, while large

societies tend towards the opposite in each case, being uniform in physical type but more variant in cultural patterns.[11] The variability of physical type is due to the existence of mutant genes which have a better chance of finding phenotypic expression homozygously in a small community. The cultural pattern is however uniform because there is not sufficient room for a man with different tastes.

There is a parallel in modern society. The individual worker feels so powerless in the presence of his strong employer. Only by identifying himself with a Union of some kind can he feel secure. A small Culture with little total power in the face of Nature, presents the same condition, and the individual within it has only one hope in the struggle, and that is to identify himself completely with the group which then acts as a 'larger self.The odd man, the individualistic thinker, is suspect – just as the man who refuses to join the Union is suspect. As Clive Bell put it, the native who stops to think in such a society runs the risk of stopping altogether![12] By the same token the little man cannot afford to arouse the suspicions of his Union.

Now as such early societies developed, there would be an increasing measure of control of the environment until some degree of personal liberty would be permissible. Yet so long as the feeling of kinship with an all powerful Cosmos existed, such individualism would be restricted. The ideal of an Egyptian Gentleman was a man who never disturbed things. The same has been true in Chinese society. It was true in England until new forces came into play which upset the old accepted patterns. We shall revert to this point later.

Even the expression of emotion is discouraged – for it reveals the inner feelings to who knows what hostile invisible (or visible) forces. If one must express feelings, then they are to be shown *violently*, as a warning. This is exactly the way primitive man thinks about such things.

Goldenweiser speaks of the occasional new insight and its fate. He says:[13]

> It is of course inevitable with man that deliberation and therefore awareness will here and there break into the course of the industrial process. But the spark of intellectual discernment flickers but for a moment, presently to go out again. What is passed on to the following generation is the objective result, not the intellectual insight. This is so because these pursuits, one and all, are direct and pragmatic. What is aimed at is achievement, not understanding.

He thus refers to such culture growth as being by involution rather than by evolution.[14]

> This feature has often been commented on by observers of primitive life. The all pervading ceremonialism of the Todas, the interminable exchanges of presents attending Trobriand marriages, the minute apportionment of a hunting booty among the Central Australians (just such and such a piece to such and such a relative), the elaborateness of Maori or Marquesan Art (arts that overreach themselves), the ravages of taboo in Polynesia (taboo run amuck) – all of these and many similar cultural traits exhibit development by involution.

So each society permits development by slight changes in the existing patterns but always within itself as it were. An extra little kick of the foot in a ceremonial dance, a new gesture added (at first with trepidation) in a traditional pantomime, a very slight change of angle in a pattern used for vase decoration. And so on. By these, men preserved some small measure of individualism.

But extraordinary limitations were placed on ritual modifications, simply because the whole universe – including the society performing it – was personally involved as a single unit. The 'crowd' character here asserted itself enormously. The individual had ceased to exist. Yet not entirely, for the group was drawn into one person and personally represented by the King or the Priest.

In all this, preservation is the watchword. Tradition is the wisdom of the ages. The old men were its repositories, and they kept their knowledge in secret societies to which no youngster was admitted.

This pattern of distrust for innovation survived even in Europe and England until remarkably recent times. The reception accorded a series of inventions which we now take for granted, was at first uniformly hostile. Samuel Martin[15] made a special study of this some years ago. Among the products to the introduction of which great resistance was offered he lists Coal, Printing, the Ribbon Loom, the Stocking loom, Table forks [!], the Sawmill, the Steam Engine, Tea [!], the Spinning-Jenny, Steamboats, Railways, the use of Gas, Macadamized Roads [!], and some other items that seem essential to us today which were at first refused in almost every case on the grounds that they would upset the status quo of Society.

But two things brought about change, one of them probably always having operated in this way. The first is 'contact' with other Cultures; the second is a 'philosophy of change' which began to become really apparent when the Theory of Evolution gained general acceptance.

Some of the factors which lead to such culture contacts are the following: change of climate leading to migration, increase in population leading to expansion into new territories, the disappearance of a source of supply (metals, food, wood, etc.), the emergence of a notable 'Royal Family' and the establishment of an ambitious dynasty with plans for empire building, the desertion of an area due to plague or the increase of a pest or of wild animals, and – most important of all – *roads*, whether navigable rivers or easily traversed valleys, etc. Harold Innis made much of the existence of such means of communication and rightly stressed the fact that the highest early cultures were all on navigable waterways that encouraged culture contact and the exchange of goods and ideas.[16] This is true of Europe, the Middle East, Asia, India, and the Far East, where the earliest lines of communication on a large scale were rivers and river valleys. Such contacts inevitably lead to cultural change.

Ideas are like parents, they generate ideas in turn, and no two people even though most hostile ever come into contact without some exchange taking place, often, as in the case of the early centuries of our era, as a result of taking prisoners.

Sir Flinders Petrie, speaking of the Cycles of Civilization, which have so intrigued philosophers of history, says in this connection:[17]

> We have represented the wave of Civilization as falling to a minimum, and suddenly rising again. To what is this change due? In every case in which we can examine the history sufficiently we find that there was a fresh wave coming into the country when the earlier wave was at its lowest.
>
> In short, every civilization of a settled population tends to incessant decay from its maximum condition; and this decay continues until it is too weak to

> initiate anything, when a fresh race comes in and utilizes the old stock to graft on, both in blood and culture.

This has been the case it seems in both the Old and the New World. Ernst Kretschmer[18] arrived at the conclusion, in regard to the share that the Nordic race has had in Western Culture, that their most marked contributions were developed only in those regions where this race has been exposed to intensive mixture with other races. And he holds it to be certain that regions inhabited by the purest Nordic breeds are relatively poor in genius and cultural activity. The most advanced European Cultures never had their spiritual centres, he argues, in Scandinavia or in the northern coasts of Germany, or in Scotland: but always where racial mixture has taken place.

The sudden emergence of high civilizations in the New World in pre-Columbian times is not so easy to account for. But the sudden upsurge in the New World since the Discovery is surely traceable to this factor of race mixture. Speaking of this, Harry L. Shapiro[19] pointed out that while the figures are very approximate only, there are some 6,000,000 people of mixed racial origin in Europe, whereas the relative number of people of mixed racial origin in the New World is vastly greater so that, as he puts it, "we can have little hesitation in recognizing that the latter is the main centre of race mixture in modern times." And in the same connection Fenton B. Turck says:[20]

> Americans have captured the extraordinary vitality which Science has proved is typical of the first few generations of a people with mixed blood strains.

This shows to some extent why ancient high civilizations did not proceed further. Their world-view so homogenized their own particular culture that they were not willing or capable of accommodating much in the way of an exchange of values or ideas. Some exchange occurred of course, but not comparable at all to the phenomenon of our own age – and in primitive societies the pattern is even more concretely apparent. Indeed, such societies are in most cases so homogeneous that any disruption of the pattern practically destroys the whole structure. This has been the testimony of history ever since the White Man began to explore and exploit the World for himself – from the destruction of the Indus Valley Culture by the Aryans to the virtual destruction of American Indian Culture by ourselves.

C. G. Seligman observes the same in China. As he says:[21]

> The T'ang period, perhaps that of China's greatest brilliance was marked by the influx and acceptance of foreigners and of foreign [Western and Indian] ideas.

E. B. Reuter[22] of the University of Iowa, published a paper on the consequences of race mixture some years ago in which he gave illustrations of the fact that both in societies and in individuals 'mixed blood' can have remarkable results so long as the culture does not degrade the so-called 'half-breed' socially. This was at that time quite a bold statement, because much was then (1930) being made of the desirability of purity of racial origins. The argument of Kretschmer is given added weight when Reuter observes:[23]

> The same general position is supported by a body of negative evidence. The population groups in the modern world with the highest approximation to

> racial purity are just those groups of most meagre cultural accomplishment. The fragments of primitive groups still living are the purest in blood and the lowest in culture of existing populations....

From all this it is evident that the exchange of ideas and techniques has a value in itself. Yet possibly we could go a step further. The exchange may take place between two cultures whose world-view is analogous, as for example two non-Indo-European or two IndoEuropean cultures. It may also take place between two cultures with distinctly different world-views. Which kind of contact produces the most notable results? I venture to suggest that it is clearly the latter, and that the lack of advance in early times in spite of trade and commerce is traceable to the fact that the exchange took place between people of similar 'philosophy.' It was essentially therefore an exchange of techniques and artefacts, but nothing more. It was Cultural Involution.

Not until the sudden expansion of Indo-European trade and commerce, with a great increase in travel and the communication of ideas, did any real Cultural Evolution take place.One wonders whether, if this should become in time 'One World,' we shall also settle down to the mediocrity of one World-View? Would that be the beginning of the end of progress?

Education Leading To Philosophy

Why has this intellectual contribution of Indo-Europeans been so liberating in this way? I think partly because it opened up a new method of investigation of Nature. It is hard now to realize what the first Greek Philosophers actually undertook to do. The

Ionians began asking improper questions. They exercised unbelief in a world which was full of blind faith in the wisdom of its traditional answers. Frankfort describes this bold step:[24]

> The doctrines of the early Greek philosophers are not couched in the language of detached and systematic reflection. Their sayings sound rather like inspired oracles. And no wonder, for these men proceeded with preposterous boldness, on an entirely unproved assumption. They held that the Universe is an intelligent whole.
>
> They presumed that a single order underlies the chaos of our perceptions, and, furthermore, that we are able to comprehend that order.

The whole-ness of the Universe had not been doubted by their predecessors. It was however whole-ness of another kind. It was the whole-ness of a Society held in check by conflicts of wills with some in power in some areas, and others in other areas. Often these powers were at loggerheads, yet like a kind of Hobbesian State, they got along with each other because it paid to do so. Such was the Babylonian view, and certainly the religious heritage of the Greeks was a pantheon of very similar deified but squabbling characters.

They somehow came to the dangerous conclusion that the order in the world which they perceived with characteristically Indo-European mind could not have resulted from such a chaotic kind of government. In one bold stroke they began to look suddenly for another kind of cause and effect.

Magic was never the father of Science, for the whole concept of magic is not compatible. It is a personalistic view of the forces or wills of Nature. I believe that in spite of all that has been written by such men as Malinowski,[25] Rivers,[26] and Thorndike,[27] and many other anthropologists, they are in error in attributing to magic the status of a kind

of pseudo-science. Its accidental findings may have contributed to the world's technical wealth (as for example in medicine) but its spirit is entirely alien to the scientific attitude. As religion is an attitude of *I - Thou,* Magic is an attitude of *I - thou* (with a small *t*), but Science is an attitude of *me - it.* This was the new Greek spirit.

Frankfort says subsequently:[28]

> There is nowhere a precedent for the [new] type of argument [they were proposing]. It shows a twofold originality. In the first place, early Greek philosophy ignored with astonishing boldness the prescriptive sanctities of religious representation. Its second characteristic is a passionate consistency. Once a theory is adopted, it is followed up to its ultimate conclusion irrespective of conflicts with observed facts or probabilities ...
>
> The absence of personification, of gods, sets it apart from mythopoeic thought.

Thus they at last escaped from the bondage of the *I - Thou* attitude of the non-Indo-European. Their attitude became in time, truly objective. It opened the way for a re-examination of all the older theories; and it opened the way for experiment. Unbelief became a key concept. It still is. There is a curious inversion of historical processes here, for while Faith had led to Technology, unbelief carried Technology into Science. The part played by early religious beliefs in the stimulation of Technology is not popularly recognized. Lord Raglan[29] emphasises it. He argues that in the earliest times, only the priestly class had means or leisure to spend time elaborating techniques. Religion called forth man's highest skill and demanded perfection of technique in building, metal work, and drama. It was the wealthy Temples that demanded record keeping and trained scribes for the task. Its priests were appropriately clothed in the finest raiment. Sacrifice led to

much knowledge of anatomy, and burial customs played their part here also. Education owed its inception to the need for exact preservation of the Faith. The stars were studied for signs and omens, and the organization of community life for the undertaking of large buildings and ceremonies was greatly stimulated by religious faith, and so was the creation of literature and epic poems.

In fact it is probably true that without such a world-view, man's thinking would have been largely incoherent and fruitless. It has moreover, been shown that those small liberal arts colleges with a Theological Foundation have actually produced the largest number of notable Scientists in America.[30] Perhaps it is because, faulty though its views may sometimes prove to be, theology still makes sense out of experience as a whole, and a man works better when he has some kind of orientation.

Education Leading To Science

So much for Technology then. But Science has progressed by doubt, by scepticism, by asking questions that challenge accepted beliefs. Recently, Maurice B. Visscher remarked:[31]

> It has been said that the real essence of the scientific frame of mind is the "duty to doubt" as long as it is reasonably possible to do so. On the contrary, with respect to revealed religion, the "will to believe" is a cardinal virtue.

Even so, the great new venture of the Scientific Method with all its vast consequences for mankind might have been somewhat fruitless in its impact had it not been for the emergence, largely as a result of Darwin's *The Origin of Species: By Means of*

Natural Selection, of a new climate of opinion which now looks upon change as being in itself and of itself a measure of advance. To change something – anything – is a worthwhile undertaking.

So popular has the concept become, so violently has tradition and 'the old way' been cast aside as outmoded, that we have even made a virtue out of novelty itself.

By undermining the sanctions of any kind of religious faith, and entirely divorcing the supernatural from the natural order as though it were no longer relevant, the whole tenor of educational emphasis has changed. The scientists, properly, for their purposes could ignore the spiritual element in their search for power over things. But the public, going one step further, denied entirely what the scientists had merely ignored. Then the latter followed suit.

And so education has shifted its emphasis from ends (the subject of philosophy) to means (the subject of technology), and therefore inevitably from wisdom (which belongs to experience and has a moral quality in it) to knowledge (which can be equally the possession of a saint or a knave). Homo sapiens becomes Homo sciens, and as more and more courses are devoted to 'know how' in place of 'know why,' the essential role of the philosopher is overlooked altogether.

Yet this philosophical attitude of mind is our unique contribution as Indo-Europeans. It is this which has brought us to the threshold of conquering even space itself. We are not greatly inventive, nor have we any superior ingenuity. We have been wonderful borrowers and our memory of the debt is short.

I think if this un-inventiveness were to need demonstration, it has unexpectedly received it both in the United States and in Great Britain in recent years. Large corporations have, with great expectations, been setting up research laboratories in ever increasing number for over a quarter of a century. The endowments of some of the Research Centers have often been fantastic. Yet as Stafford Hatfield[32] points out, in England at least the results have been almost as disappointing as the amount of money spent on them. Very little has come out of it all. Evidently the Indo-European, with all the equipment in the world, is not so good at inventing things as we have imagined him to be.

And the picture in the New World is much the same. The government of the United States has laid so much emphasis upon research directed specifically to the solution of practical and immediate problems that the real scientists are becoming frightened and at times almost neurotic.

J. C. Warner, President of the Carnegie Institute of Technology, was quoted a few months ago in the *Scientific American*, as follows:[33]

> Government emphasis on applied research has so disorganized University work that many scientists are living a life of intellectual chaos. Their energies have been channelled away from ... creative research....
>
> I do not believe that any board, committee, agency, administrator, or the scholar himself can predict ahead of time the most fruitful direction a scholarly study will take....
>
> Government support ... of team research ... does not produce the new generalizations, ideas, and comprehensive theories which constitute the essence of new science.

In such situations, the scientists themselves are often the first people to admit the lack of new ideas. It is the urgency of finding answers to practical problems, a kind of glorified

technological treasure hunt that is drying up the stream of inspiration at its source. *This* kind of search might far better be given to the Technologist. Let him by all means get guidance from the Scientist, but leave the Scientist free to examine the pabulum of Technology as he will, and to use the technician's skill to aid him in the quest.

The results will be far more fruitful if my thesis is in any sense a correct interpretation of history.

Then, education-wise, the budding scientist, the individual who most clearly reflects the Indo-European turn of mind, should be educated and trained by all possible means to exercise this faculty with all his might, and to give far less attention to practical problems that currently exist. He should be a theorist, not a super-mechanic. I suspect that a good technologist will solve more practical problems more effectively and in less total time, than any one who is not by nature inventive but is the stuff out of which scientists can be made. Somehow it should be possible to sort out these two kinds of people, (scientist and technologist) taking as a starting point their racial origin, and using tests thereafter to refine the process of identification. Not everyone will by any means fall in either category. But there are those, the scientists, who are by nature sceptical, challenging every assertion and every traditional view. If there is in such minds something more than merely a negative attitude towards things in general, such men could be disciplined by those who have proved themselves to be philosophically competent. The critical faculty is essential to science, but this requires training, and a high degree of objectivity which must be engendered. But this kind of training is not much help to the intensely practical

mind, or to the inventive individual, the technologist. Restraints have a deadening effect on the scientist: he must somehow be allowed to believe the impossible. What he needs is encouragement, and freedom, and when he has learned how to ask the right questions, often the technologist will prove indispensable to him.

Money is needed both for Search and *Re*-search. The former could be undertaken by the Non-Indo-European, the latter by the Indo-European, if we allow these classifications to stand for mental attitudes rather than a slavish insistence upon a birth certificate of proper origin. Part of the problem of specialization might find its solution here, for the scientist need not be swamped for much of his Course with practical matters, nor the Technician with theoretical ones. Each becomes qualified in his own way to be a co-worker with the other, without the presently existing unpleasantness of professional jealousy and distrust of trespassers.

Of course, such Utopian schemes seldom work out as expected. Yet the implications of my Thesis are here in a nutshell. On the basis of a study of the history of Technology and the history of Philosophy we seem to have clear evidence, it seems to me, that there is such a thing as a Technical mind that works best in the invention of *things*, and such a thing as a Philosophical mind that works best in the invention of *ideas*. Only very exceptionally are they combined in one individual, and– on the contrary– many individuals have neither specifically enough to single them out. Together, they can produce wonders – but in independence, the capacity of each proves to be remarkably limited in the long run. It may be that such a bifurcated system of Education would require a bifurcated form

of communication, too: specific and concrete and actual for the one, generalized and abstract and theoretical for the other. But then, I suppose, there would have to be a *lingua franca* to enable each group to communicate with the other!

And thus, in the end, like all such schemes, the system would prove entirely impractical. Yet – as an Indo-European, and according to my own Thesis, it is both proper and perhaps inevitable that such impossible theories should be invented and philosophized about!

ANNOTATED BIBLIOGRAPHY

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BOOKS:

Cassirer, Ernst, *An Essay on Man: An Introduction to a Philosophy of Human Culture,* Yale, 1944, xii and 237 p., index.

A study of man's capacity for the creation and use of symbols, which is his altogether unique cultural activity. Cassirer owes much to other thinkers in the fields over which his Essay ranges (language, art, science, history, etc.) but his major contribution is in his power of synthesis.

Relative to my Thesis, Chapter 7 on Language is probably the most important.

Like Whorf, Cassirer is keenly interested in the relationships which exist between language and thought, but unlike him he is essentially a Philosopher rather than a Linguist as Whorf was. The place of the Word as a handle by which people, things, ideas, and whole situations are grasped, filed in the memory, and manipulated by the mind, is his main concern. Since this faculty distinguishes man from the animals, he is particularly interested in those who lack this power, as for example feral children, and blind deaf-mutes.

Primitive people may be 'primitive' in part because they have not been able to establish 'free' association between words and what they stand for. How some blind deaf-mutes have overcome this, and the transformation it brought into their personality is noted.

Conant, James B., *On Understanding Science: An Historical Approach,* New American Library, N.Y., 1951, xvi and 144 p., bibliography, index.

This study was based on a series of lectures given at Yale University. Conant subsequently put his own proposals into effect at Harvard in his courses on Science as a Method and Attitude of Mind. He considers that the best and possibly the only way to understand the true nature of Science is by studying its rise in a historical context. He lays great stress on the need for distinguishing between Technology and Science, and proposes that the most effective method is by studying how the two differ but interact upon one another, using case histories for the purpose. The volume is small, but full of keen insights.

Crawford, M. D. C., *The Conquest of Culture: How Man Invented His Way to Civilization,* Fairchild, N.Y., 1948, xii and 449 p., bibliography, index.

This is a valuable study of Technology in which invention is related to the environment and historical setting that called it forth. The style is 'narrative' but

the author has sufficiently mastered the specific areas of the subject matter he chooses for illustration that he is able to write smoothly without being superficial. His bibliography is quite representative, though the latest reference is dated 1937. There are useful sections on Textiles, Metallurgy, and Transportation.

Farrington, Benjamin, *Science in Antiquity*, Oxford, 1936, 256 p., short bibliography, index.

The arrangement of this useful little book is characteristic of most modern treatments of Science History. A brief survey is made of the 'science' of Egypt, and of Mesopotamia (24 p.), and then the author considers early Greek Science and the Ionian Schools, etc. He is quite clear as to the relative appropriateness of the term 'science' as applied to pre-Greek thought; and underscores its mystical foundation and practical objectives. The indifference of the Greeks to experiment is emphasised and this is held to be largely responsible for the final eclipse of their Science. The contribution of Hindu philosophers is not taken into account: and there is no reference to the Far East.

Frank, Philipp, *Philosophy of Science: The Link Between Science and Philosophy*, Prentice Hall, Englewood Cliffs , N.J., 1957, xxii and 394p., index.

This volume is correctly titled, and shows among other things that philosophy is essential for the construction of scientific ideas. I felt this volume should have been very valuable to me in the preparation of the Thesis, but for some reason it did not prove to be so. I am not sure why.

He holds that the teacher of Philosophy, History, or English, has a much greater influence on the intellectual and emotional makeup of the average college student than the teacher of Chemistry for example.

He underscores the importance of wisdom as opposed to mere knowledge. He argues that the scientist who belittles philosophy and says he is not concerned with it, is merely proving himself to be a poor philosopher.

The central problem of education for science, be holds, is the nurturing of the power of generalization - and this he feels is developed by philosophical exercise. He also points up the need for mental discipline and training in the use of logical argument. The most important scientific 'doctrines' today are really philosophical ones.

Frankfort, H., and H. A. Frankfort, John A. Wilson, Thorkild Jacobsen, and William A. Irwin, *The Intellectual Adventure of Ancient Man: An Essay on Speculative Thought in the Ancient Near East*, University of Chicago, 1946, viii and 401 p., index.

ANNOTATED BIBLIOGRAPHY

A series of Papers dealing with the world-views of the people who created the great Middle East Civilizations in Mesopotamia, the Nile Valley, and Palestine. Complete unanimity is expressed as to the mystical and non-scientific nature of all the speculative thought of these people. Emphasis is placed on the concept of the Universe as a Society of Wills. My use of the descriptive phrase 'I-thou' etc., was derived from this volume.

Goldenweiser, Alexander, *Anthropology: An Introduction to Primitive Cultures*, Crofts, N.Y., 1937, xxii and 550 p., bibliography, index, illustrations, and end-plate maps locating some primitive cultures.

Goldenweiser was a keen student of Culture as a phenomenon of all human societies. This book summarizes much of his thinking and gives many valuable insights into the factors which govern or influence the preservation or change of culture content in any given area.

He deals with arts and skills, magic and religion, politics, education, diffusion, and the relation of culture content to environment. His concern is not with specific cultures only, but in a generalized way with cultures as structured and integrated patterns or wholes.

Jevons, Frank B., *An Introduction to the History of Religion*, Methuen, London, 1896, viii and 443 p., index.

Jevons had a lucid and easy style and a very keen insight into the nature of animistic beliefs. His theme is that man did not at first distinguish between his own will and the forces of nature. When his expectations that he could enter into an agreement with nature were disappointed, man's reaction was to belittle his own influences and powers. Thus arose the sense of awe – religion. This is, of course, the view of a man who seeks to find the basis of man's religious behaviour and motivation apart from Revelation.

Much of what he says seems applicable to the view of nature adopted by ancient civilized man, and to some extent by modern peoples who have either lost or badly corrupted the original revelation that seems clearly to have been given to man.

He lays particular stress on the importance of the 'unexpected' in such personalistic world-views. His treatment of Totemism is useful. His documentation is good, and extended – but frequently lacks dates.

Lévy-Bruhl, Lucien, *How Natives Think*, translated by Lilian A. Clare, Allen & Unwin, London, 1926(?), 392 p., index.

ANNOTATED BIBLIOGRAPHY

This book has been a most controversial one, and because of the unfortunate use of a term 'pre-logical' as applied by the author to primitive thinking, it has been somewhat discredited by those who did not find the native to be unlike themselves in their thinking processes. However Levy-Bruhl subsequently tried to make it clear that he did not mean 'illogical' but, more exactly, 'logically based on premises of another kind'. The laws of contradiction are not recognized, he claims, only in the sense that premises are often held which we would consider to be mutually contradictory. He gives many illustrations.

His main argument throughout is that natives think emotionally, and are seldom objective in the strict sense we feel they should be, when objectivity is not a matter of life and death.

They 'experience' their thinking, and are involved in everything they perceive with any intensity. Their language structure, he believes, bears witness to this tendency. His illustrations are drawn from a very wide range of native societies from all over the world. It is difficult to see how he could be altogether mistaken.

Moscati, Sabatino, *Ancient Semitic Civilizations*, Elek Books, London, 1957, 254 p., bibliography, index, illustrations.

This volume surveys usefully what is now known from Archaeology about the Semitic Cultures of the Middle East, a classification based on language and not strictly on 'racial origins.' It includes the Babylonians, Assyrians, Canaanites, Hebrews, Aramaeans, Arabs, and Ethiopians.

Reference is made to the distinctiveness of Semitic languages with respect to their grammatical construction. The Hittites he believes had an Indo-European aristocracy: the Canaanites were an amalgam of people, with an amalgam for their religion. They had a high technical proficiency from which the Hebrews learned much.

Radin, Paul, *Primitive Man as Philosopher*, Dover Publications, N.Y., 1957, xliv, 402 p., bibliography, index.

This volume contains material intended to demonstrate the existence of Philosophers among the primitive people selected by the Author. These are the Winnebago, Oglala Sioux, Zuni, Maori, Baganda, Ewe, Batak, Buin, Tahitans, and Hawaians.

In the text of my Thesis an evaluation of Radin's views is offered. In summary it may be said that he has perhaps underestimated the influence of culture contacts with Western man. Many of these very striking illustations may

owe much to this influence, unconsciously absorbed by the natives in question. It is, however, a work that seriously challenges my Thesis, being as far as I know the only such study. The author is clear, I think, on the essential nature of Philosophy.

Sarton, George, *A History of Science: Ancient Science Through the Golden Age of Greece*, Harvard, 1952, xxvi, 646 p., index, illustrations.

A valuable survey, of which the first 159 pages deal with pre-Ionian 'science.' including early Greek writers such as Homer and Hesiod, and of course Mesopotamia, Egypt, Anatolia, and Minoan Crete.

The contribution of China is statedly omitted from consideration as being a subject in itself. Mathematics receives considerable attention.

His view is essentially that the 'ancients' had a science of a sort, by which he seems to mean that their technology was on the whole rational and effective.

Singer, Charles, and E. J. Holmyard, A. R. Hall, and Trevor I. Williams, editors, *A History of Technology*, Oxford, 1954-57, in 3 Volumes. Each volume contains maps, illustrations, plates, and an index.

These volumes are composed of a series of papers, each with a bibliography, written by experts in their respective fields. The authors are strictly concerned with Technology as it relates to mechanical engineering, civil engineering, food and clothing, ceramics, printing, power devices and sources, instrumentation, mining and metallurgy, military technology, marine engineering, chemical industries, transport, furniture, building, and some others. They do not touch upon the history of Science except in so far as technicians provide the tools of measurement.

Volume one, lxiv, 827 pages, covers from the earliest times to the fall of the Ancient Middle East Empires. It deals also with some technical aspects of tool making, speech, community life, time-reckoning, and so forth.

Volume two, lx, 802 pages, deals with the Mediterranean Civilizations and the Middle Ages, from c. 700 B.C. to A.D. 1500.

Volume three, xxxviii, 766 pages, carries the story from the Renaissance to the Industrial Revolution, c. 1500 to c. 1750 A.D.

More Volumes are planned.

Whorf, Benjamin Lee, *Collected Papers on Metalinguistics*, Foreign Service Institute, Dept. of State, Washington, 1952, iii 72 p., illustrated.

ANNOTATED BIBLIOGRAPHY

A series of papers appearing priginally in various journals, all of them dealing with the relationship af language to world-view.

Language, Thought, and Reality, selected writings of B.L. Whorf, edited by John B. Carroll, with a foreword by Stuart Chase, Technology Press, M.I.T., 1956, xii, 278 p., bibliography.

This is a more extensive Collection of Whorf's papers. The general theme continues to be the same. It was an area in which Whorf pioneered, making a unique contribution which is all the more surprising in view of the fact that it was an avocation with him. Whorf was by training and profession a highly successful Chemical Engineer specializing in fire prevention as related to Chemical Industries.

* * * *

JOURNALS:

Bernard, Jessie, "Can Science Transcend Culture?" in *The Scientific Monthly*, Vol. 71, October 1950, pp. 268-273.

It was the title of this paper which suggested to me a title for my Thesis. Her object is to show, among other things, that Science is not the mere accumulation of data which automatically reveals the Laws of Nature. These Laws are mental creations. As such they are limited by and subject to laws of thought, which in turn are conditioned by language.

Thus at the root of the 'Laws of Nature" lies the language of the 'discoverer.' Different languages lead to the formulation of different laws of relationship even when applied to the same data. And, as a corollary, some languages will not permit the 'discovery' of the same laws which other languages have.

Scientific thought is not 'common sense' applied logically to the 'givens' of Nature to produce order and meaning which has an absolute validity.

One of the self-correctives which will perhaps have to be applied in the teaching of Science will be some awareness of the culturally conditioned elements which result from the language.

ANNOTATED BIBLIOGRAPHY

Gladston, Iago, "The History of Research", presented in 5 parts, in *Ciba Symposia*, Vol. 8, June-July, 1946, pp. 338-372, with bibliographies and illustrations.

This issue was titled "Search and Research"

The titles of the 5 parts are as follows:

Wanted – a History of Research.
The Beginnings of Research.
The Dawn of Experimental Science.
The Rise of Modern Research.
Research in the United States.

Essentially, the text deals with the Greek Schools, the rise of Learned societies, the establishment of modern Research Institutes, and the general nature of Research as such. There are many generative ideas, though the text is more strictly historical than philosophical in emphasis.

* * * *

INTRODUCTION

[1] Muir, James, "The Challenge of China," a report published by the Royal Bank of Canada, Montreal, June, 26, 1958, 1.

[2] Schultz, Adolph, "Man and the Catarrhine Primate" in *Symposia of Quantitative Biology*, Biological Laboratory, Cold Spring Harbor, New York, NY, 1950, vol. 15, 49.

[3] Andrews, Alfred C., "The Bean and the Indo-European Totemism," *The American Anthroplogist*, 51, Apr.-June, 1949, 274-290. It may be noted that Heraldry is not considered to be a form of Totemism; Lord Raglan, "Totemism and Heraldry," *Man*, 60 Aug. 1955, 128.

[4] Sarton, George: quoted by Benjamin Farrington, as a prologue, *Science in Antiquity*, Oxford, UK, Home University Library of Modern Knowledge, 1947.

[5] Sarton, George, *A History of Science*, Cambridge, MA, Harvard University Press, 1952, 16. He expressess the opinion that pre-Greek Technology was Science, though admittedly "very poor science."

[6] Conant, James B., *On Understanding Science: an Historical Approach*,"Oxford, UK, Mentor Books, New York, NY, 1951, 35, 36.

CHAPTER ONE

[1] Lévi-Strauss, Claude, "Race and History" in the series *The Race Question in Modern Science*, UNESCO, Paris, 1952, 27.

[2] Ackernecht, Erwin, H., "The Eskimo's Fight Against Hunger and Cold," *Ciba Symposia* Vol. 10, July-Aug. 1948, 894.

[3] Wulsin, Frederick, R., "Adaptations to Climate Amongst Non-European Peoples," in *The Physiology of Heat Regulation and the Science of Clothing*, edited by L.H. Newburg, Philadelphia, PA, Saunders, 1949, 26.

[4] Jeffreys, Charles, W., *A Picture Gallery of Canadian History*, Toronto, ON, Ryerson, 1942, Vol. 1, 113.

[5] Ackernecht, Erwin. H., *op cit.*, (ref. #2), 897.

[6] Sayce, Archibald, H., "Archaeology and Its Lessons," in *Wonders of the Past*, edited by Sir John Hammerton, London, UK, Putnam's, 1924, Vol. 1, 10.

[7] Davies, H.M., "Liberal Education and the Physical Sciences," *Scientific Monthly*, (66)5, May, 1948, 422.

[8] Sayce, A.H., *op. cit.*, Putnam's, (ref. #6)11..

[9] Weyer, Edward, "The Ingenious Eskimo," *Natural History*, New York, NY, published by National History Museum, May, 1939, 278, 279.

[10] An illustration of such an instrument is given by Alexander Goldenweiser, *Anthropology*, New York, NY, Crofts, 1937, 85, fig. 23.

[11] Marsh, D.B., "Inventions Unlimited," *The Beaver*, The Hudson's Bay Co., Dec., 1943, 40.

[12] Lapham, Macy H., "The Desert Storehouse," in *Scientific Monthly*, 66(6), June, 1948, 451 ff.

[13] Evenari, Michael, and Dov Koller, *Ancient Masters of the Desert*, *Scientific American*, April, 1956, 36ff.

[14] Clark, J. Grahame, "New World Origins," *Antiquity*, 14(54), June, 1940, 118.

[15] Stirling, Matthew, "America's First Settlers, the Indians," *National Geographic Magazine*, Nov., 1937. 592.

[16] Macgowan, Kenneth, *Early Man in the New World*, Macmillan, New York, NY, 1950, 199.

[17] Crawford, Morris D. C., *The Conquest of Culture*, New York, NY, Fairchild, 1948, 145, 146.

[18] Collins, J.L., "Pineapples in Ancient America," *Scientific Monthly*, (66)11, Nov., 1948, 372.

[19] Herskovits, Melville, *Man and His Works*, New York, NY, Knopf, 1950, 250.

[20] King, F. H., *Farmers for 40 Centuries*, Emmaus, PA, Rodale Press, reviewed in *Scientific Monthly*, 66, December, 1948, 448 by W. M. Myers, under the title "Those Clever People."

[21] Murdock, George P., *Our Primitive Contemporaries*, New York, NY, Macmillan, 1934, 167.

[22] Linton Ralph, *The Tree of Culture*, New York, NY, Knopf, 1956, 83.
[23] Cotton, Clare, M., "Animals: Old Hands at Angling," *Science News Letter*, Mar. 6, 1954, 155.
[24] Raglan, Lord , *How Came Civilization?* London, UK, Methuen, 1939, 130.
[25] Gudger, E. W. "Fishing with the Cormorant in Japan," *Scientific Monthly*, 29, July, 1929, 5ff.
[26] Murdock, G. P., *op. cit.*, (ref. # 21), 51.
[27] Coon, Carleton S., *A Reader in General Anthropology*, New York, NY, Henry Holt, 1948, 220.
[28] Heizer, Robert F., "Aboriginal Fish Poisons," Paper No. 38, in *Anthropological Papers*, Bulletin 151, Smithsonian Institution, Washington, DC, 1953, 225, 283. Several hundred poisons are listed.
[29] Coon, C. S. *op.cit.*,(ref. #27), 220.
[30] Darwin, Charles, *Journal of Researches*, New York, NY, Ward, Lock, & Co., preface dated 1845, 206 ff.
[31] Lubbock, Sir John, *Prehistoric Times*, New York, NY, New Science Library, J.A. Hill, 6th. ed., revised, 1904, 201.
[32] Bolas: see Robert Braidwood, *Prehistoric Man*, Chicago, IL, Field Museum of Natural History, in Popular Series: Anthropology, No. 7, 1948, 56.
[33] Boomerangs: these have also been reported from Egypt at Badari by Vere Gordon Childe, *New Light on the Most Ancient East*, London, UK, Kegan Paul, 1935, 65: and in Europe, by Herbert Wendt, *I Looked for Adam*, London, UK, Weidenfeld & Nicolson, 1955, 356.
[34] Farwell, George, "The First Known Guided Missile," reprinted in the *Globe & Mail*, (Toronto, ON, Saturday, August 29, 1953, 17), as a feature article from the Australian Government Publication, *South West Pacific*.
[35] Sarton, George, *A History of Science*, Cambridge, MA, Harvard, University Press, 1952, 5.
[36] Tschopik Jr., H., "The Aymara," in the *Handbook of South American Indians*, published by the Bureau of American Ethnology, 1946, Vol. 2, Bulletin 143, 501-573.
[37] Elkin, Adolphus P., *Aboriginal Men of High Degree*, Queensland University John Murtagh Macrossan Memorial Lectures, of 1944, published by Australasian Publications, 1946.
[38] Read, Grantly Dick, *No Time for Fear*, reviewed by W. A. Deacon in the Saturday Review of Books, *Globe & Mail*, Toronto, ON, August 11, 1956.
[39] Huxley, Aldous, "History of Tension," *Scientific Monthly*, 87, July, 1957, 4, 5.
[40] Truth serum: referred to by Robert Lowie, *Social Organization*, New York, NY, Rinehart, 1948, 168, 169.
[41] Levi-Strauss, C., *op. cit.*, (ref. # 1), 27.
[42] Linton, Ralph, *The Study of Man*, New York, N.Y, Appleton Century, Student's Edition, 1936, 90.
[43] Popham, Robert, "Trepanation as a Rational Procedure in Primitive Surgery," *University of Toronto Medical Journal*, 31(5), February, 1954, 204-211.
[44] Lowie, Robert, *An Introduction to Cultural Anthropology*, New York, NY, Farrar & Rinehart, 2nd. ed., 1940, 336.
[45] Heizer, Robert, "The Use of the Enema by the Aboriginal American Indians," *Ciba Symposia*, 5, February, 1944, 1686..
[46] Nordenskiold, Erik, "The American Indian as an Inventor," *Journal of the Royal Anthropological Institute*, 59, 1929, 273, ff.
[47] Ants used for suturing: see E. A. Underwood,(*Nature*, 175, February 19, 1955, 318) reviewing Lewis Cotlow, *Amazon Head Hunters* (London, UK, Robert Gale, 1954).
[48] Ackernecht, Erwin, in *Ciba Symposia*, 10, July-August, 1948, 924, in a note under the title "An Ingenious Device for Stitching Wounds." The same author has a paper entitled "Primitive Surgery," (*American Anthropologist*, New Series 49, January-March, 1947) in which he gives a bibliography on the subject of 204 references.
[49] Rubber enemas: this is the opinion of E. Nordenskiold, "The American Indian as an Inventor," *op. cit.*,

(ref. #46), 298,

[50] Anonymous article in *Rubber Age*, November, 1956, 365.

[51] Charles Goodyear: see on this, H. Stafford Hatfield, *The Inventor and His World*, Harmondsworth, UK, Penguin Books, 1948, 41-44.

[52] Murdock, G. P., *op. cit.* (ref. #21), 428, 429.

[53] White, C. Langdon, "Storm Clouds over the Andes," *Scientific Monthly*, May, 1950, 308.

[54] Crawford, M.D.C., *op cit.*, (ref. #17), 184, 185.

[55] Felt: see Mabel C. Cole and Fay Cole, *The Story of Man*, Chicago, IL, Cuneo Press, 1940, 374.

[56] Whistling kettles: on this see T. Athol Joyce, "Marvels of the Potter's Art: In South America" in *Wonders of the Past*, edited by Sir John Hammerton, London, UK, Putnam's, 1924, Vol. 2, 464, 465.

[57] Ropes: see Alexander Goldenweiser, *op. cit.*, (ref. #10), 402 and Victor W. von Hagen, *Realm of the Incas*, New York, NY, New American Library, 1957, 186, 187 for illustrations.

[58] Road rollers: see Marshall H. Saville, "The Ancient Maya Causeways of Yucatan," *Antiquity*, March, 1935, 73.

[59] Paper in South America: see Victor W. von Hagen, "The First American Papermakers," *The Paper Industry & Paper World*, December 1944, 1133.

[60] Lewis, Gilbert, "The Beginnings of Civilization in America," *American Anthropologist*, New Series 49, January-March, 1947, 8 and footnote.

[61] Moodie R.L., quoted by Mason, J. Alden, *The Ancient Civilizations of Peru*, Harmondsworth, UK, Penguin, 1957, 222, 223.

[62] Rifled arrowheads: I have one of these in my possession. There are several references to them in the literature and some examples in Museums in Canada and the United States. There may have been a family, a kind of Iroquois Krupps, which supplied friend and foe alike – at a price! Edward B. Tylor refers to them *(Anthropology*, New York, NY, Hill, 1904, 155), and even earlier, Sir William Dawson, *Fossil Men and Their Modern Representatives*, London, UK, Hodder & Stoughton, 1883, 124. There seems to be no doubt about their intentional design.

[63] Aymara boats: see Stewart E. McMillin, "The Heart of Aymara Land," *National Geographic Magazine*, February, 1927, 213-256.

[64] Barnhouse, Donald G., "The Editor Visits Mexico's Mayan Ruins," *Eternity Magazine*, May, 1956, 35.

[65] Glass saws as reported in *Science News Letter*, July 13, 1957, under the title "Glass-toothed Saw Cuts Wood: An Ingenious Hand-made Tool May Provide a Solution for an Ancient Scientific Puzzle." (Anonymous).

[66] Tooth filling: see Sigvad Linné, "Technical Secrets of American Indians," *Journal of the Royal Anthropological Institute*, 87, Part II, July-December, 1957, 152, 153, and 163.

[67] Toothpaste: *Science News Letter*, December 23, 1956, 390, in a series of brief notes written anonymously under the heading "Anthropology -Archaeology."

[68] Toothbrush: see Curt Proskauer, "Oral Hygiene in the Medieval Occident," *Ciba Symposia*, 8, November, 1946, 468. The illustration is from a woodcut in the Lei Shu Ts'ai Hiu, a Chinese Encyclopedia.

[69] Nordenskiold, E., *op. cit.*, (ref. #46), 281.

[70] Nordenskiold, E., *op. cit.*, (ref. #46), 302, from North Western Brazil.

[71] Nordenskiold, E., *op. cit.*, (ref. #46), 302.

[72] Nordenskiold, E., *op. cit.*, (ref. #46), 302, used by a small tribe, the Hurari, in Matto Grasso, and found nowhere else in South America.

[73] Nordenskiold, E., *op. cit.*, (ref. #46), 300.

[74] Sandpaper: see Leonard Adam, *Primitive Art*, Harmondsworth, UK, Penguin, 1949, 162.

[75] Fireflies: see Donald C. Peattie, "The Miracle of the Firefly," *The Reader's Digest*, October 1949, 102.

[76] Needham, Joseph, *Science and Civilization in China*, Cambridge, UK, Cambridge University Press, 1954, Vol. 1, 54.

[77] Prof. T. F. McIlwraith, Head of the Department of Anthropology in the University of Toronto, gave a lecture on the various means adopted by different people to test aspiring husbands. The Arawak of Central Africa adopt this method, as do other widely scattered tribes. An early chapter of Genesis (4: 17-21) gives prominence to the first city-builder, the first agriculturalist, the first tent-dweller, the first musician, and the first metal worker. The latter is referred to as Tubal-Cain, which some authorities feel may be the original form of the word *Vulcan*, who was (like many Chinese inventors) subsequently 'deified.'

[78] Childe, Vere Gordon, "India and the West Before Darius," *Antiquity*, 13(49), March, 1939, 15.

[79] Childe, Vere Gordon, *New Light on the Most Ancient East*, New York, NY, Kegan Paul, 1935, 2.

[80] Meek, T. J., in a lecture given in the Orientals Department, University of Toronto, ON, Fall, 1936.

[81] Usher, Abbott Payson, *A History of Mechanical Inventions*, Cambridge, MA, Harvard University Press, 1954, p. 154.

[82] Meek, T. J., "Magic Spades in Mesopotamia," *University of Toronto Quarterly*, 7, 1938, 243, 244.

[83] Neugebauer, Otto, and A. Sachs, *Mathematical Cuneiform Texts*, New Haven, CT, Yale University Press, (for the American Oriental Society, and the American School of Oriental Research), 1946, 35.

[84] Sarton, George, *op. cit.*, (ref. #35), 73, 74, 99, and 118.

[85] Neugebauer, Otto, "Ancient Mathematics and Astronomy," in *A History of Technology*, ed. by Charles Singer, *et al.*, Oxford, UK, Oxford University Press, 1954, Vol. 1, 799.

[86] Kramer, Samuel N., *From the Tablets Of Sumer*, Indian Hills, CO, Falcon's Wing Press, 1956, xviii, 6, 32, 58, 59.

[87] Jourdain, Philip E. B., "The Nature of Mathematics," in *The World of Mathematics*, ed. by James R. Newman, New York, NY, Simon & Schuster, 1956, Vol. 1, 10-13.

[88] Reavely, S. D., "The Story of Accounting," *Office Management*, April, 1938, 8. ff.

[89] Wiseman, P. J., *New Discoveries in Babylonia about Genesis*, London, UK, Marshall, Morgan & Scott, 2nd. revised edition, (undated), 30.

[90] Boscawen, St. Chad, in discussing a paper by Sir William Dawson, "On Useful and Ornamental Stones of Ancient Egypt," *Transactions of the Victorian Institute*, 26, 1892, 284.

[91] Dubberstein, Waldo H., "Babylonians Merit Honor as Original Fathers of Science," *Science News Letter*, September 4, 1937, 148, 149.

[92] Vavilov, N. I., "Asia the Source of Species," *Asia*, 37(2), February, 1937, 113.

[93] Childe, V. G., *What Happened in History*, Harmondsworth, UK, Penguin, 1942, 64.

[94] Eisler, Robert, "Loan Words in Semitic Languages Meaning 'Town'," *Antiquity*, 13(52), December, 1939, 449 ff.

[95] Wiseman, P. J., *op. cit.*, (ref. #89), 28, 31, and 33.

[96] Petrie, Sir Flinders, *The Wisdom of the Egyptians*, British School of Archaeology, Publication No. 63, 1940, 89.

[97] Childe, V. G., op. cit., (ref. #79), 67, note 85.

[98] Howard, J. Eliot, "Egypt and the Bible," *Transactions of the Victorian Institute*, 10, 1876, 345.

[99] Perry, W. J., *The Growth of Civilization*, Harmondsworth, UK, Penguin, 1937, 54.

[100] Magoffin, Ralph N., "Archaeology Today," *The Mentor*, April, 1924, 6.

[101] Reported under the title, "Batteries B.C.," *The Laboratory*, 25 (4), 1956, published randomly by Fisher Scientific Company, Pittsburgh, quoting Willard F. M. Gray of the General Electric Company's High Voltage Laboratory, in Pittsburgh. Gray reconstructed these batteries on the basis of archaeological materials.

[102] Evans, Sir Arthur, *The Palace of Minos*, London, UK, Macmillan, in 5 Volumes (plus an Index Volume) beginning publication in 1921.

[103] See *Bulletin of the Royal Ontario Museum of Archaeology*, 11, March, 1932, 7.

[104] Meek, T. J., "The Present State of Mesopotamian Studies," *Haverford Symposium of Archaeology and the Bible*, American Schools of Oriental Research, New Haven, CT, 1938, 161.

[105] Spearing, H. G., "Susa, the Eternal City of the East," in *Wonders of the Past*, edited by Sir J. Hammerton, London,UK, Putnam's, 1924, Vol. 3, 582,

[106] Bibliography on Aegean Pre-history:

Blegen, Carl W., *Zygouries: A Prehistoric Settlement in the Valley of Cleonae*, Cambridge MA, Harvard, University Press, 1928.

.Bosanquet, R. C., *Excavations at Phylakopi in Melos*, Macmillan, 1904.

Dinsmoor, W.B., *The Architecture of Ancient Greece*, London, UK, Batsford, 1950.

Evans, Sir Arthur, *The Palace of Minos*, London, UK, Macmillan, 4 Vols., 1921-1935.

Heurtley, W. A., *Prehistoric Macedonia*, Cambridge, UK, Cambridge University Press, 1939.

Holmberg, Erik J., *The Swedish Excavations at Asea in Arcadia*, Lûnd, Sweden, Gleerup, 1944.

Mylonas, George, *Prehistoric Macedonia: Studies in Honour of F. W. Shipley*, Washington University Series Language and Literature, No. 14, 1942, 55 ff.

Pendlebury, John D. S., *The Archaeology of Crete*, London,UK, Methuen,1939.

Seager, Richard B., "Explorations in the Island of Mochlos," *American School of Classical Studies at Athens*, published in Boston, 1912.

Valmin, M. Natan, *The Swedish Messenia Expedition*, Oxford, UK, Oxford University Press, 1938.

Wace, Alan J. B., *Prehistoric Thessaly*, Cambridge, UK, Cambridge University Press, 1912.

Weinberg, Saul, "Neolithic Figurines and Aegean Interrelations," *American Journal of Archaeology*, 55 April, 1951, 121 ff.

Xanthoudides, Stephanos, *The Vaulted Tombs of Mesara*, Liverpool University Press, and London, UK, Hodder & Stoughton, 1924.

And, of course, numerous articles on the Linear Scripts, which have now been deciphered and which originated in Crete, having been adopted by the Greeks subsequently.

[107] de Beer, Sir Gavin, "Who Were the Etruscans?" *The Listener*, BBC, Dec., 8, 1955, 989.

[108] Pallottino, Massimo, *The Etruscans*, Harmondsworth, UK, Penguin, 1955, 46-73.

[109] Rawlinson, George, *The Origins of the Nations*, New York, NY, Scribner, 1878, 111.

[110] MacIver, D. Randall, "The Etruscans," *Antiquity*, 1, June, 1927, 171.

[111] Holmyard, E.J., "The Language of Science" (editorial), *Endeavour*, 4(14), April, 1945, 41.

[112] Smith, Edwin W., and Andrew M. Dale, *The Ila Speaking Peoples of Northern Rhodesia*, London, UK, Macmillan, 1920, Vol. 2, 342.

[113] Coon, C. S., *op. cit., (ref. #27)*, 340.

[114] Ackernecht, Erwin. "Primitive Surgery," *op. cit.*, (ref. #48), 32.

[115] Anonymous, "The Story of Coffee," in *The Plibrica Firebox*, 22, July-August, 1948, 4,5. (Published by Plibrico Firebrick, Toronto, ON.)

[116] Forbes, R. J., *Metallurgy in Antiquity*, Leiden, NL, Brill, 1950, 64.

[117] Kramer, Samuel N., *op. cit.*, (ref. #86).

[118] "A Cinematograph Touch in Ancient Egyptian Art: Wall-paintings that Suggest Moving Pictures," reproduced from P. E. Newberry's "Beni Hasan," in the *Illustrated London News*, Jan., 12, 1929, 50, 51.

[119] Hambly, Wilfrid D., "A Walt Disney in Ancient Egypt," in a Letter to the Editor of 'animated animal figures' behaving like people! (*Scientific Monthly*, October, 1954, 267, 268, with illustrations).

[120] Gloves and camp stools: See Axel Persson, *The Religion of Greece in Prehistoric Times*, Berkeley, CA, University of California, 1942, 77.

[121] Soap: see on this Rendel Harris, "Soap," in the *Sunset Papers*, published privately in England, 1931.

[122]Tools: see, George M. A. Hanfmann, "Daidalos in Etruria" *American Journal of Archaeology*, 39, April-June, 1935, 192 ff.

[123]Brace and bit: an illustration of this is given in *The Illustrated London News*, (April 12, 1930, p. 623), in a series of articles by G. H. Davis and S.R.K.Glanville entitled "Life in Ancient Egypt: Astonishing Skill in Arts and Crafts."

[124] Levels: see George Sarton, *op., cit.*, (see ref.#35), 124, footnote 94.

[125] Lathes: see Charles Singer, *et al.*, *A History of Technology*, Oxford, UK, Oxford University Press, 1954, Vol. 1, 192 and 518.

[126] Apel, Willi, "Early History of the Organ," *Speculum*, 23, 1948,191-216.

[127] A number of bronze castings used in the construction of these large umbrellas are to be seen in the Royal Ontario Museum Toronto.

[128] Well known from the monuments and from seals. The line drawing in Fig. 20. is probably from a seal.

[129] Linton, Ralph, *op. cit.*, (ref. #22), 114.

[130] Vaccines: see Melville Herskovits, *op. cit.*, (ref.#19), 246.

[131]Malleable glass: the details of this are given by Stanko Miholic, "Art Chemistry," *Scientific Monthly*, 63, December, 1946, 460.

[132] Hornell, James, "Primitive Types of Water Transport in Asia: Distribution and Origins," *Journal of Royal Asiatic Society*, 1946, Parts 3 and 4, 124-141.

[133] Needham, J. *op. cit.* (ref. #76), Vol. 1, 240-243.

[134] Article by Isabella L. Bishop, "Koreans," in the *Encyclopedia Britannica*, 14th ed., 1937, Vol. 13, 489, with illustration.

[135] Naphtha: as we have already mentioned, the Chinese piped this gas as early as 450 B.C. But it was also used by the Babylonians for divination purposes according to R. J. Forbes, "Chemical, Culinary, and Cosmetic Arts," *A History of* Technology, ed. by Charles Singer, *et al*, Oxford, UK, Oxford University Press, Vol. 1, 1954, 251. By the same author, it is said to have been used by the Sumerians probably, in furnaces for heating metals, (*Metallurgy in Antiquity*, Leiden, NL, Brill, 1950, 111).

[136] Forbes, R.J., in "A History of Technology," Vol. 1, 293.(See Ref. #135)

[137] Leakey, L.S.B., in "*A History of Technology*," (see ref. #135), Vol. 1, 149. This is possibly begging the point a little! It is assumed from the nature of certain paintings that they were done by blowing (or splattering) the paint from the mouth (!) using baffles to limit it as required. Certainly it does seem to have been sprayed, somehow.

[138] Cigarettes: see note, under the title "The Sacred Cigarette" it is reported that thousands have been found in cave-shrines as native offerings in Arizona (in section "Far and Near," *Discovery*, 19(6), June, 1958, 262). We have already mentioned cigar-holders: and of course, the Indians were the originators of the pipe for smoking tobacco.

[139] Spectacles: see Ethel J. Alpenfels, anthropologist with the Bureau for Intercultural Education, in an article entitled "Our Racial Superiority," abstracted in *The Reader's Digest*, September, 1946, p. 81, from *Catholic World*, July, 1946, 328 ff.

[140] Safety pins: illustrated in *Antiquity*, 1, June, 1927, 170 in an article by D. Randall MacIver, "The Etruscans."

[141] Schweig, Bruno, "Mirrors," *Antiquity*, 15(59), September, 1941, 259.

[142] Windows: see Phyllis R. Feuner, *Giants, Witches, and a Dragon or Two*, New York, NY, Knopf, 1943, 185.

[143] Abacus: these experiments were reported as a note in the magazine *His*, (Chicago, IL, IVF publication, Oct., 1957, no page numbering), under the title "Misplaced Conceit."

[144] du Noüy, Comte, *Human Destiny*, New York, NY, Longmans Green, 1947, 139.

[145] Under the title "Science and Civilization in China," in the section "The Progress of Science," *Discovery*,

Nov., 1957, 458.

[146] Butterfield, Herbert, *The Origins of Modern Science,* London, UK, Bell, 1949, 163.

[147] Multhauf, Robert, Book review in *Science* 124, Oct., 5, 1956, 631.

[148] Fung, Tu-Lan, "Why China has no Science," *Internations Journal of Ethics,* 1922, 237-263.

[149] Polo, Marco, *The Travels of Marco Polo,*New York, NY, Library Publications, (undated) Chapter 24, 137-140.

[150] Needham, J.M., *op. cit.* (ref., #76), Vol. 1, 241. But there is some question about the Screw Principle, Archimedes may have 'borrowed' it from Egypt.

[151] Needham, J.M., *op. cit.,* (ref. #76), Vol. 1, 244.

[152] Needham, J.M., *op. cit.,* (ref. #76), Vol. 1, 245.

[153] Needham, J.M., *op. cit.,* (ref. #76), Vol. 1, 241.

[154] Sarton, George, *op. cit.,* (ref. #35), 5, fn 4.

[155] Repeating Bow: this is described in the *Bulletin of the Royal Ontario Museum of Archaeology,* No. 10, May, 1931, 11, under the title Crossbow.

[156] Lamb, Harold, "Flame Weapons,"*Chemical Warfare Magazine,* Edgewood, (U.S.), Dec., 1927, 237.

[157] "The Story of Chemical Warfare," (no author stated), Jan., 1939, 1.

[158] Maude, A., "Ancient Chemical Warfare," *Journal of Royal Army Medical Corps,62,* 1934, 141.

[159] Klopsteg, Paul E., *Turkish Archery and the Composite Bow,* privately published in Toronto, 2nd. ed., 1947.

[160] Coggins, Jack, and Fletcher Pratt, *Rockets, Jets, Guided Missiles and Space Ships,* New York, NY, Random House, 1951, 4, with foreword by Willey Ley.

[161] Ley, Willey, "Rockets," *Scientific American,* Mar., 1949, 31.

[162] Forbes, R.J., *op.cit.,* (ref#116), 442.

[163] Conder, C.R., "The Canaanites," *Transactions of the Victoria Institute,*. 24, 1890, 51.

[164] Miller, Francis T., *The World in the Air,* New York, NY, Putnam's, 1930, Vol. 1, 99.

[165] Miller, Francis T., *ibid,* 56.

[166] Miller, Francis T., *ibid,* 73.

[167] Needham, J., *op.cit.,* (ref.# 76), Vol. 1, 231.

[168] Needham, J., *op.cit.,* (ref. #76),Vol. 1, 231.

[169] Stern, H. J., *Rubber: Natural and Synthetic,* London, UK, Maclaren, 1954, 118.

[170] Clapperton, R. H., and William Henderson, *Modern Paper Making,* Oxford, UK, Blackwells, 2nd. edition, revised, 1941, 376 pages.

[171] Bender, George A., "Pharmacy in Ancient China" in the series, *A History of Pharmacy in Lectures,* Parke Davis Pharmaceutical Co., 1957.

[172] See Edward Farber, reviewing Li Ch'iao-p'ing, *The Chemical Arts of Old China, The Scientific Monthly,* 68, June, 1949, 430.

[173] This is reported in an *Annual Project Report* issued by the U.S. Quartermaster Stores, Jan.-Dec., 1956, 401.

[174] Needham, Joseph, Wang Ling, and Derek J. Price, "Chinese Astronomical Clockwork," *Nature,* 177, March 31, 1956, 600, 601.

[175] Haddon, Alfred C., *The History of Anthropology,* London, UK, Watts, 1934, 33.

[176] Reported in *The Telegram,* Toronto, April 4, 1955, in a special section devoted to the use of Natural Gas; under the title "Gas and Pipeline too: way back in 450 B.C."

[177] Forbes, R. J., *op. cit.,* (ref.#116), 407.

[178] Hermann, Paul, *Conquest by Man,* New York, NY, Harper, 1954, xxi, xxii.

[179] Needham, Joseph, *op. cit.,* (ref. #76), 240.

[180] Maritain, Jacques, An Introduction to Philosophy, translated by E.I. Watkin, New York, NY, Sheed and Ward, 1937, 26.

CHAPTER TWO

[1] Evans, Sir Arthur, "The Palace of Minos," London, UK, Macmillan, 1921, Vol. , 1, 16.
[2] Coon, Carleton S., *The Races of Europe*, New York, NY, Macmillan, 1939, 178.
[3] Sarton, George, *A History Science*, Cambridge, MA, Harvard, 1952, 5, fn.2.
[4] Perry, William J., *The Growth of Civilization*, Harmondsworth, UK, Penguin, 1937, 157.
[5] Raglan, Lord, *How Came Civilization?* London, UK, Methuen, 1939, 179.
[6] Needham, J., *Science and Civilization in China*, Cambridge, UK, Cambridge University Press, 1954, Vol. 1, 240.
[7] Clark, J. Grahame D., "New World Origins," *Antiquity*, 14(54), June, 1940, 118.
[8] Childe, V. Gordon, *New Light on the Most Ancient East*, London,UK, Kegan Paul, 1935, 203.
[9] Linton, Ralph, *The Tree of Culture*, New York, NY, Knopf, 1956, 300.
[10] Raglan, Lord, *op. cit.*, (ref. #5), 179.
[11] Albrecht-Carrié, René, "Of Science, Its History and the Teaching Thereof," *Scientific Monthly, 63(1)*, July, 1951,19. Even the so-called Arabic numerals are actually Indian. See Linton, *op. cit.*, (ref.#9), 296.
[12] Boscawen, St., Chad, *The Bible and the Monuments*, London, UK, Eyre and Spottiswoode, 1896, 18.
[13] Breasted, James, *Ancient Times: a History of the Early World*, London, UK, Ginn and Co., 1935, 160.
[14] Grau, R. F., *The Goal of the Human Race*, London, UK, Simpkin, Marshall, Hamilton and Kent,1892, 88, 91.
[15] Winter, H.J.J, "Muslim Mechanics and Mechanical Appliances," *Endeavour*, Jan., 1956, 25, 26.
[16] Bernard, Jessie, "Can Science Transcend Culture," *Scientific Monthly,"* Oct., 1950, 271.
[17] Cassirer, Ernst, "The Influence of Language on the Development of Scientific Thought," *Journal of Philosophy*, 39, June, 1942, 323.
[18] Whorf, Benjamin Lee, *Collected Papers On Metalinguistics*, Foreign Service Institute, Dept. of State, Washington, DC, 1952,
[19] Langer, Susanne, *Philosophy in a New Key*,New York, NY, Mentor Books,1948, Chapters 2, 3, 4, and 5 in particular.
[20] Radin, Paul, *Primitive Man as Philosopher*, New York, NY, Dover Publications, 1957.
[21] Lévy-Bruhl, Lucien, *How Natives Think*, translated by L.A.Clare, London, UK, Allen and Unwin, 1926.
[22] Lévy-Bruhl, Lucien, *ibid, 15.*
[23] Martain, Jacques, *An Introduction to Philosophy*, New York, NY, Sheed and Ward, 1937, 25.
[24] Radin, P., *op. cit.*, (ref. # 20), 276.
[25] Radin, P., *op. cit.*, (ref. #20), 236.
[26] Radin, P., *op. cit.*, (ref. #20), *387.*
[27] Radin, P., *op. cit.*, (ref. #20), 396
[28] Maritain, Jacques, *op. cit.*, (ref. #23), 23.
[29] Engberg, Martin, *The Dawn of Civilization*, New York, NY, University of Knowledge Series, Cuneo Press, 1938, 153.
[30] Gardiner, Sir Alan, *Egyptian Grammar*, Oxford, UK, Oxford University Press, 1927, section 3, 4.
[31] Hayes, William C., "Daily Life in Ancient Egypt," *National Geographic Magazine*, Oct., 1941, 425, 426, 427, and 428.
[32] Newman, James, R., "The Rhind Papyrus," in *The World of Mathematics*, of which he was the editor, New York, NY, Simon and Schuster, 1956, Vol. 1, 170.
[33] Jourdain, Philip, E.B., "The Nature of Mathematics," in *The World of Mathematics*, edited by J.R.Newman, Simon and Schuster, 1956, Vol. 1. 11.
[34] Jourdain, P.E.B., ibid, 12.
[35] Jourdain, P.E.B., *ibid*, 14.
[36] Stewart, Ileen, "Helminths in History, *Scientific Monthly*, 72(6), 1951, 348.

CHAPTER TWO

[37] Baikie, James, *The Story of the Pharaohs,* London, UK, Black, 1908, 59.
[38] Bell, Clive, *Civilization,*, Harmondsworth, UK, Penguin Books, 1938, 63.
[39] Forbes, R.J., *Metallurgy in Antiquity,* Leiden, NL, Brill, 1950, 46.
[40] Farrington, Benjamin, *Science in Antiquity,* Oxford, UK, Home University Library, 1947, 24.
[41] Whitehead, Alfred, N., "Mathemathics as an Element in the History of Thought," in *The World of Mathematics,* edited by J.R. Newman, New York, NY, Simon and Schuster,1956, Vol. 1, 409.
[42] Whitehead, A.N. *ibid,* 410.
[43] Whitehead, A.N. *ibid,* 412.
[44] Hatfield, H. Stafford, *The Inventor and His World,* Harmondsworth, UK, Penguin Books, 1948, 38.
[45] Hatfield, H.S., *ibid,* 39.
[46] Robertson, E.H., "The Beliefs of Science," *The Listener,* BBC, (London, UK), Jan 28, 1954, 183.
[47] Frankfort, H, and H.A. Frankfort, *et. al., The Intellectual Adventure of Ancient Man,* Chicago, IL, University of Chicago Press, 1946, 3.
[48] Needham, J., *op. cit.,*(ref/ #6), Vol. 2, 1,
[49] Dubs, Homer, H., Book review, *Endeavour,* July, 1957, 178.
[50] Needham, J., *op. cit.,* (ref. #6),Vol. 2, 467.
[51] Wilson, Epiphanius, in the Introduction to *The Literature of China,* in *The World's Greatest Classics,* New York, NY, Colonial Press, Renaissance Edition, Vol. 39, 1900, 3, 4.
[52] Watts, Alan, W., "How Buddhism Came to Life," *Asia,* Oct., 1939, 581.
[53] It is hardly necessary to give references from the proverbs of Solomon, but a few sayings of Pachacuti (or Pachacutec) may be of interest:

Envy is a worm that gnaws and consumes the entrails of the envious.

It is very just that he who is a thief should be put to death.

Adulterers who destroy the peace and happiness of others, ought to be declared thieves and punished with death as such.

Judges who secretly receive gifts from litigants ought to be looked upon as thieves and punished with death as such.

The noble and generous man is known by the patience he shows in adversity.

Such sayings are the accumulated wisdom of many, born of experience, and expressed pithily in a few words.

These examples are taken from Philip A. Means, "The Incas: Empire Builders of the Andes," *National Geographic Magazine,* Feb., 1938, 251.

[54] Multhauf, Robert, Book review in *Science,*124, Oct. 5, 1956, 631.
[55] Needham, J., *op. cit.,* (ref. #6), Vol. 2, 85.
[56] Kroeber, Alfred, L, *Configurations of Culture Growth,* Berkley, CA, University of California, 1944, 184.
[57] Wu-Chi, Liu, *A Short History of Confucian Philosophy,* Harmondsworth, UK, Penguin Books, 1955, 9.
[58] Fothergill, Philip G., *Historical Aspects of Organic Evolution,* London, UK, Hollis and Carter, 1952, 10.
[59] Fothergill, P.G., *ibid,* 9
[60] Everyman's Encyclopedia, London, UK, J.M.Dent, 1913 Edition, Vol. 10, 305, 306.
[61] Partington, J.R., reviewing T*he History of Chemistry in Ancient and Medieval India,* edited by Professor P. Rây, in *Nature,* Jan. 5, 1957, 5.
[62] Linton, Ralph, *The Study of Man,* NewYork, NY, Student's Edition, Appleton-Century, 1936, 343.
[63] Kroeber, A.L., *Anthropology,* New York, NY, Harcourt Brace, 1948, 2
[64] Lowie, Robert, *An Introduction to Cultural Anthropology,*New York, NY, Farrar and Rinehart, 1940, 340.
[65] Chapin, Miriam, *How People Talk,* Toronto, ON, Longmans Green, 1947, 121.

CHAPTER TWO

[66] Hegel, Georg, W. F., *The Philosophy of History*, in *The World's Great Classics*, New York, NY, Colonial Press, Vol. 20. 161, 162.
[67] Maritain, J., *op. cit.*, (ref.#23), 25.
[68] Maritain, J., *op. cit.*, (ref. #23), *26.*
[69] Maritain, J., *op. cit.*, (ref. #23), 27.
[70] Maritain, J., *op. cit.*, (ref. #23), 39.
[71] Jourdain, Philip, *op, cit.*, (ref. #33), Vol. 1, 12.
[72] Hoijer, Harry, "The Relation of Language and Culture", in *Anthropology Today*, edited by A. L. Kroeber, Chicago, IL, University of Chicago Press, 1953, 558.
[73] Forbes, R.J., *op. cit.*, (ref. #39), 407.
[74] Rochow Eugene G., *An Introduction to the Chemistry of the Silicones*, New York, NY, Wiley, 1946, 60-62.
[75] Canning, Dermot, "Science Utilizes Silicones," *World Science Review*, Feb., 1958, 25.
[76] Wilson, George, "On Electric Fishes as the Earliest Electric Machine Employed by Mankind," *The Canadain Journal*, New Series, 13, Jan., 1858, 58ff.
[77] Wilson, G., *ibid*, 69.
[78] Dietz, David, *Cultural Values of Physics*, in the Smithsonian Report for 1940, 143.
[79] Kondo, Herbert, "Michael Faraday," *Scientific American*, Oct., 1953, 93.
[80] Hafsted, L.R., "The Role of Scientists and Engineers in Society," The Tool Engineer, Apr., 1957, 223.
[81] Farrington, B., *op. cit.*, (ref. #40), 68.
[82] Usher, Abbott P., *A History of Mechanical Inventions*, Cambridge, MA, Harvard University Press, 1954, 59.
[83] Raglan, Lord, *How Came Civilization?* London UK, Methuen, 1939, 176.
[84] Conant, James B., *On Understanding Science*, New York, NY, Mentor, 1951, 117.
[85] Clark, R.A. *Six Talks on Jung's Psychology*, Box Press, Pittsburg, PA.

CHAPTER THREE

[1] Balfour, Henry, "The Fire-Piston," in *Anthropological Essays*, Presented to Edward B. Tylor, Oxford, UK, Oxford University Press 1907. Especially 17-19 and 37.

[2] Raglan, Lord, *How Came Civilization?* London, UK, Methuen, 1939, 15.

[3] Kroeber, A.L., "Stimulus Diffusion," in *American Anthropologist*, 42, Jan., 1940, 1, 2.

[4] Farrington, Benjamin, *Science in Antiquity*, Oxford, UK, Home University Library, 1947, 190.

[5] Poincaré, Henri, *Science and Method*, New York, NY, Dover Publications, 16.

[6] Farrington, B., *op. cit.*, (ref. #4), 193.

[7] Dircks, Henry, *The Life, Times, and Scientific Labours of the Second Marquis of Worcester*, London, UK, Quaritch, 1865, 452.

[8] Galdston, Iago, "The Dawn of Experimental Science," *Ciba Symposia*, Vol. 8. June-July, 1946, 350.

[9] Galdston, Iago, "The Rise of Modern Research," *Ciba Symposia*, Vol. 8, June-July, 1946, 354, 355.

[10] Kramer, Samuel N., *From the Tablets of Sumer*, Indian Hills, CO, Falcon's Wing Press, 1956, 63.

[11] Cassirer, Ernst, *Essay on Man*, New Haven, CT, Yale University Press, 1944, 82.

[12] Middleton, John, reviewing Daryll Ford, (editor) *African Worlds: Studies in the Cosmological Ideas and Social Values of African People, (Nature*, Oct. 16, 1954, 715).

[13] Tylor, Edward B., *Anthropology*, New York, NY, Hill, New Science Library, 1904, 41.

[14] Muller, Max, quoted by C.G.Jung, *Psychology of the Unconscious*, translated by Beatrice M. Hinkle, London, UK, Dodd and Mead, 1947, ix.

[15] Dennis, Wayne, "Animististic Thinking Among College and University Students" *Scientific Monthly*, Apr., 1953, 247-249.

[16] Whewell, William, *The Philosophy of the Inductive Sciences Founded upon Their History*,London, UK, Parker, 1840, Vol. 2, 213, 276.

[17] Hallowell, A.I., "Myth, Culture and Personality," *American Anthropologist*, Dec., 1947, 547.

[18] Frankfort, H., and H.A. Frankfort, *The Intellectual Adventure of Ancient Man*, Chicago, IL, University of Chicago Press, 1946, 7.

[19] Hoijer, Harry, "The Relation of Language to Culture," *Anthropolgy Today*, edited by A.L. Kroeber, Chicago, IL, University of Chicago Press, 1953, 562.

[20] Melvin Kyle, quoted by Chester K. Lehman, "Biblicism and Science," *Journal of The American Scientific Affliation*, 6, Dec., 1954, 4.

[21] Frenkel-Brunswik, Else, "Meaning of Psychoanalytic Concepts and Confirmation of Pasychoanalytic Theories," *Scientific Monthly*, Nov., 1954, 293.

[22] Whorf, B.L., "Language, and Logic" in the *Technology Review*, (April, 1941), republished with several other papers under the title *Collected Papers on Metalinguistics*, Washington, DC, Department of State, 1952, 21.

[23] Whorf, B.L.: quoted by Alexander Gode, "The Case for Interlingua," *Scientific Monthly*, Aug., 1953, 90.

[24] Whorf, B.L., *Language, Thought, and Reality, Selected Writings*, edited by John B. Carrol, Boston, MA, Massachusetts Institute of Technology Press, 1956, 252.

[25] Heller Keller, stated by her teacher, Miss Anne Sullivan, in the section written by her, in *The Story of My Life*, New York, NY, Grosset and Dunlap, 1905, 419.

[26] Tung-San, Chang, quoted by Warren Weaver, " Science and People", *Science*, 122, Dec., 30, 1955, 1258.

[27] Tomlinson, H.M., quoted by Warren Weaver, (ref. #26) 1258.

[28] Cassirer, E., *Essay on Man*, New Haven, CT, Yale University Press, 1948, 135.

[29] Hammer-Purgstall, quoted by Cassirer, *ibid*, 135.

[30] Wells, Herbert G., *Outline of History*, edited by Raymond Postgate, New York, NY, Doubleday, new enlarged edition, 1949, Vol. 1, 150.

CHAPTER THREE

[31] Lévy-Bruhl, Lucien, *How Natives Think*, translated by Lilian A. Clare, London, UK, Allen and Unwin,
[32] Chapin, Miriam, *How People Talk*, Toronto, ON, Longmans Green, 1947, 27.
[33] Farrington, B., *op. cit.*, (ref. #4), 15.
[34] Bettelheim, Bruno, "Schizophrenic Art: a Case Study," *Scientific American*, Apr., 1952, 30-34.
[35] Cassirer, Ernst, *Language and Myth*, New York, NY, Dover Publications, 1946, 51.
[36] Cassirer, E., *ibid*, 33.
[37] Chase, Stuart, *The Tyranny of Words*, New York, NY, Harcourt, Brace, 1938.
[38] Linton, Ralph, *The Tree of Culture*, New York, NY, Knopf, 1956, 113.
[39] Campbell, Douglas, and C.R.Congdon: reported by Stuart Chase, *op. cit.*, (ref. #37), 86.
[40] Cassirer, E., *op. cit.*, (ref.# 28), 40, 41.
[41] Cassirer, E., *op. cit.*, (ref.# 28), 57.
[42] Goldstein and Gelb: quoted by E. Cassirer, *op. cit.*, (ref.#28), 58.
[43] Goldstein, Kurt, "Prefrontal Lobotomy: Analysis and Warning," *Scientific American*, Feb., 1950, 44.
[44] Carothers, J.C., "The Frontal Lobe Functions and the African," *The Journal of Mental Science*, 97, Jan., 1951, 406, 12ff.
[45] Carothers, J. C., *ibid.*, 25ff.
[46] Carothers, J.C., *ibid.*, 33.
[47] Carothers, J.C., *ibid.*, 46
[48] Reported in *Science News Letter*, June 8, 1957, 360, under the title, "No Intelligence Loss from Frontal Lobe Injury."
[49] Carothers, J.C., "The African Mind in Health and Disease: as Study in Ethnopsychiatry," published by the World Health Organization, Monograph Series No. 17, 1953.
[50] Reviewed in *Journal of the Royal Institute of Public Health and Hygiene* , Nov., 1953, 16. 307-308.
[51] Freeman, Walter, and James Watt, "Behaviour and the Frontal Lobes," in the *Transactions of the New York Academy of Sciences*, May 15, 1944, 284-310.
[52] Gerard Ralph W.,"The Biological Basis of Imagination," *Scientific Monthly*, June 1946, 487.
[53] Gerard R., *ibid.*, 489
[54] Otenasek, Frank J., "Some Considerations of the Total Personality in Prefrontal Brain Surgery," *Bulletin of the Isaac Ray Medical Library*, published by Butler Hospital, Providence, RI, Vol. 1, Oct., 1953, 83ff.
[55] Otenasek, Frank J., *ibid.*, 94.
[56] Whorf, Benjamin Lee, *op. cit.*, (ref. #24), 156.

CHAPTER FOUR

[1] Sheldon, W. H., S.S.Stevens, and W.B. Tucker, *Varieties of Human Physique: and Introduction to Constitutional Psychology,* Harper, New York, NY, 1940, also Sheldon, W.H., and S.S.Stevens, *Varieties of Human Temperament: a Psychology of Constitutional Differences,* New York, NY, Harper, 1942, x.

[2] Huntington, Ellsworth, "Mainsprings of Civilization," Wiley, NY, 1945, 405, 528, 547, and 599 especially.

[3] Snyder, Laurence H., "The Genetic Approach to Human Individuality," *Scientific Monthly,* Mar., 1949, 169.

[4] Sapir, Edward, *Selected Writings of Edward Sapir,* edited by David G. Mendelbaum, University of California, 1949, 311. Sapir seems to have changed his views somewhat from previous statements on this point.

[5] Kroeber, A.L., *Anthropology,* New York, NY, Harcourt Brace, 1948, 583-592.

[6] Stern, Curt, *Principles of Human Genetics,* San Francisco, CA, Freeman,1949, 577.

[7] Frankfort, H. and H.A. Frankfort, *et al, The Intellectual Adventure of Ancient Man,* Chicago, IL, University of Chicago Press, 1946, 16.

[8] Frankfort, H. and H.A.Frankfort, *ibid.*, 149.

[9] For a photograph of a wheeled toy, see Paul Herrman, *Conquest by Man,* New York, NY, Harper 1954, fig. 32; and for a short bibliography, see Kenneth Macgowan, *Early Man in the New World,* Macmillan, 1950, 26, ref. 2.

[10] Lowie, Robert, *Introduction in Cultural Anthropology,* New York, NY, Farrar, 2nd edition,1940 336.

[11] Lebzelter, Viktor, quoted by Wilhelm Koppers, *Primitive Man and His World Picture,* London, UK, Sheed and Ward, 1952, 219, ref. 252.

[12] Bell, Clive, *Civilization,* Harmondsworth, UK, Penguin Books,1938, 43-44.

[13] Goldenweiser, Alexander, *Anthropology,* New York, NY, Crofts, 1937, 411.

[14] Goldenweiser, Alexander, *ibid,* 414.

[15] Martin, Samuel, "Opposition to Great Inventions and Discoveries," in the *Exeter Hall Papers,* London, UK, 1854-55, 461-500.

[16] Innis, Harold, "Empire and Communications," Oxford, UK, 1950, and "the Bias of Communications," University of Toronto Press, 1951.

[17] Petrie, Sir Flinders, *Revolutions of Civilization,* London ,UK, Harper, 1911, 114.

[18] Kretschmer, Ernst: quoted by Franz Weidenreich, *Apes, Giants and Man,"* Chicago, IL, University of Chicago Press, 1948, 90.

[19] Shapiro, Harry L., "Race Mixture," in the series *The Race Question in Modern Science,* Paris, France, UNESCO, 1953, 21.

[20] Turck, Fenton B., "The American Explosion," *Scientific Monthly,* Sept., 1952, 191.

[21] Seligman, C.G., "The Roman Orient and the Far East," *Antiquity,* 11, Mar., 1937, 10.

[22] Reuter E.B., "Civilization and the Mixture of Races," *Scientific Monthly,* Nov., 1930, 442 f.

[23] Reuter E.B., *ibid,* 446.

[24] Frankfort, H., and H.A. Frankfort, *et al, op. cit.,*(ref. #7), 377.

[25] Malinowski, Bronislaw, *Magic, Science, and Religion: and Other Essays,* New York, NY, Anchor Books, Doubleday, 1954, 17-92, especially 17 and 87. However, in his article "Relations of Science and Magic," under the general heading *Culture* in the *Encyclopedia of the Social Sciences,* (edited by Seligman and Johnson, New York, NY, Macmillan,1950, Vol. IV, 621-645) he seems to distinguish Magic from Science more specifically; but even here, I feel he is confusing Science and Technology.

[26] Rivers, W.H.R., *Medicine, Magic, and Religion,* Kegan Paul, New York, NY, Trench and Trubner,1927, especially 51, and 52. I believe Rivers has confused Logic and Science, and therefore held that primitive man was Scientific because he was Logical. This overlooks the differences in the premises, and the quite different view of the nature of cause and effect.

CHAPTER FOUR

[27] Thorndike, Lynn, *The History of Magic and Expermental Science,* New York, NY, Macmillan,1923, especially Vol. 1, 28, where he refers to "the solid beginnings of experimental and Mathematical science" as standing "unmistakably forth" in pre-Greek cultures.

[28] Frankfort, H., and H.A. Farnkfort, *et al, op.cit.* (ref.#7), 378, 379.

[29] Raglan, Lord, *How Came Civilization?* London, UK, Methuen, 1939, 176,178.

[30] Sampey, John R., "Training Leaders in Science and Religion," *Science,* 114, Sept, 28, 1951, 332.

[31] Visscher, Maurice, "The Duty to Doubt, and the Will to Believe," in *The Bulletin of the Atomic Scientists,* Dec., 1957, 356.

[32] Hatfield, Stafford, *The Inventor and His World,* Harmondsworth, UK, Penguin, 1948, 46-49.

[33] Warner, J. C., quoted in *Scientific American,* Feb., 1958, 40, 41, under "Science and the Citizen."

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