THE COURSE OF HISTORY:

SUBSTANTIVE PHILOSOPHY OF HISTORY AND THE SCIENCE OF HISTORY EXPLAINED

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This paper is a short version of Rochelle Forrester's book *How Change Happens: A Theory of Philosophy of History, Social Change and Cultural Evolution*

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Preface

This paper was written in order to examine the order of discovery of significant developments in history. It is part of my efforts to put the study of social and cultural history and social change on a scientific basis capable of rational analysis and understanding. This has resulted in a hard copy book *How Change Happens: A Theory of Philosophy of History, Social Change and Cultural Evolution* and a number of websites such as How Change Happens and How Change Happens Rochelle Forrester's Social Change, Cultural Evolution and Philosophy of History website. There are also papers on Academia.edu, Figshare, Mendeley, Vixra and Social Science Research Network websites and other papers on the Discovery of Agriculture, the Discovery of the Atomic World and the Constituents of Matter, and on Guttman Scale Analysis and its use to explain Cultural Evolution and Social Change. Other papers by Rochelle Forrester include, Rochelle's Philosophy Website, and works on Epistemology and the Philosophy of Perception such as Sense Perception and Reality and on Slideshare, Issuu and Scribd. Rochelle Forrester is a member of the International Network for Theory of History.

Abstract

The ultimate cause of much historical, social and cultural change is the gradual accumulation of human knowledge of the environment. Human beings use the materials in their environment to meet their needs and increased human knowledge of the environment enables human needs to be met in a more efficient manner. The human environment has a particular structure so that human knowledge of the environment is acquired in a particular order. The simplest knowledge is acquired first and more complex knowledge is acquired later. The order of discovery determines the course of human social and cultural history as knowledge of new and more efficient means of meeting human needs, results in new technology, which results in the development of new social and ideological systems. This means human social and cultural history, has to follow a particular course, a course that is determined by the structure of the human environment. Given that a certain level of knowledge will result in a particular type of society, it is possible to ascertain the types of societies that were inevitable in human history. The course of history is not random and can be rationally and scientifically understood.

This paper is about the long-term changes that have occurred in human society. It is a macro history or meta history, or a substantive theory of history and a macrosociology and a theory of social change and cultural evolution that proposes a linear progression in human knowledge and technology as the underlying cause of much social, cultural and historical change. It explains the cause of the progression and the consequences of the progression. It shows how and why humans in many environments have changed from being hunter-gatherers to being citizens of modern industrial states. It deals with the facts of scientific and technological discoveries and not with unsubstantiated or unsubstantiable speculations. It is not about events such as wars and the rise and fall of empires or dynasties, which are political events; rather it is about the intellectual and material conditions of humankind. It deals with the social and cultural history of humankind and not with political and diplomatic history.

The word "history" is a single word used to describe complex phenomena. We need to divide the phenomena into appropriate parts if we are to understand it better. Different divisions may be appropriate for different purposes. We already divide history into appropriate periods, such as ancient history, medieval history, or modern history and geographies such as African history, Indian history, Chinese history, European History or American history. We also divide it into different areas of study such as social history, cultural history, economic history, military history, history of science and history of technology.

The key to understanding the course of history is to divide history into two parts. One part follows a predetermined direction and the other part is random and unpredictable. The part that follows a predetermined direction is the part that results from ever increasing human knowledge of the world we live in. The world we live in is structured and understandable and is explained by the laws of physics, chemistry and biology and the known properties of the particles, elements and compounds that make up our world. Our ever increasing knowledge of these laws and properties of matter comes to us in a predetermined and rational order from the easiest discoveries being made first to the more difficult discoveries being made later.

Change derived from increasing human knowledge, can be contrasted with changes caused by human will, whim, luck and decision making. Such changes are easily reversible, they can swing as easily one way as another, like a pendulum, as they are subject to human whim, luck and decision making. Since the discovery of agriculture there has been a great area of civilization running from China and South East Asia, through India and the Middle East, North Africa and Europe which has been based on agriculture and which had metallurgy and writing. During the thousands of years these societies have practiced agriculture they have not shown any indication of changing back to hunting and gathering or losing metallurgy and writing. Yet during those thousands of years there has been a constant rising and falling of empires, dynasties and changes in religious beliefs. In the Middle East the Babylonian Empire was replaced by the Assyrian which was replaced by the neo-Babylonian which fell to the Persians, who succumbed to Alexander the Great, whose empire divided into Hellenic states, many of which were eventually conquered by the Romans. While all these empires came and went the practices of agriculture, writing and metallurgy and many other technologies and the social structures of the empires consisting of small landowning elites, large rural peasantries and small urban populations, remained. Rulers changed, depending on their military and diplomatic abilities and luck, but the technologies and social structure of the societies continued on. The discovery of agriculture, metallurgy and writing are cumulative changes that are not easily reversed, whereas the rise and fall of empires, dynasties and religions is a matter subject to human decision making and can go one way or another depending upon human decisions and abilities. On the other hand cumulative changes tend to be based on matters such as efficiency or what is the best solution to a problem and those matters are given and are not subject to human decision making or whims. We can of course choose to adopt the least efficient answer to a problem, but we do not normally do so. Cyclical theories of history will usually be based on and seek to explain reversible change in human history such as the rise and fall of empires. This paper however deals only with predetermined cumulative change arising from increasing human knowledge and does not attempt to explain reversible changes, such as empires rising and falling and religions beginning and ending.

This paper shows that to a large extent 'social and cultural history' follows a pre-determined and necessary path that can be analyzed and rationally understood and explained. The term social and cultural history is used as a term of art, specific to this paper and refers to changes derived from ever increasing human knowledge of the world around us. Most works on history just give a narrative describing how one thing followed another. This paper describes why one thing followed another. This involves going into areas where historians do not usually go, for example into the areas of science such as the chemical structure of rocks and the melting and smelting points of metals and ores. It is this, which enables us to state why the stone age was followed by the bronze age, which was followed by the iron age.

Human knowledge

The theory explaining the predetermined part of history arising from the ever increasing human knowledge of the environment is based upon the following ideas:

1. Human beings meet their needs by using the resources in their environment.
2. Human beings have a limited knowledge of their environment.
3. Human beings have the ability to learn and remember so their knowledge of their environment increases over time.
4. As human knowledge of the environment increases, new ways of meeting human needs become available.
5. If the new ways of meeting human needs are better than the old ways of meeting human needs they will be adopted and the old ways discarded.
6. The adoption of new ways of meeting human needs constitutes social and cultural change in itself, but also leads to further social and cultural change.
7. The order of discovery of new means of meeting human needs follows a particular path from that which is more easily discovered to that which is more difficult to discover. Many discoveries require prior discoveries before the discovery can take place. This means there is a necessary order in the discoveries that constitute and cause social and cultural change.
8. The particular order in the discoveries, means social and cultural change occurs in a particular order, so that the sequence of social and cultural change is inevitable and is rationally understandable.

All of the above statements appear to be obviously correct. If they are then the study of social and cultural history can be considered to be a science in the same way as biological evolution is considered to be a science. Social and cultural change derived from increasing human knowledge is not random and so can be scientifically understood. We cannot predict the future of social and cultural change as we do not know what future discoveries we will make. This is analogous to biological evolution where changes in living species are unpredictable as we do not know what changes will occur in the environment of those species. However biological evolution does make changes in living species rationally understandable, just as an analysis of the order of discovery of the human environment makes social and cultural change rationally understandable.

The starting point in this development is the human being itself. Human beings have the ability to learn and they have this ability above and beyond that of any other living species. This capacity is used to meet various human needs or desires. A consideration of human needs is necessary for two reasons. First, human needs direct human interests and research into particular directions or areas. This direction in combination with the opportunities our environment allows us for meeting our needs sets the course of human historical development. Secondly, human needs are a requirement for the adoption of new inventions or ideas. They will not be adopted unless a need for them exists.

Many human societies have changed from hunting and gathering to farming and/or pastoralism and then to being industrial societies. What was necessary for this to happen? Obviously a knowledge of agricultural and pastoral practices and of the technology required for industrial society. Without this, the change from hunter gathering to farming and pastoralism and then to industrial society could not have taken place. The knowledge came from the capacity of humans to learn and from the human desire to meet certain needs in a better and more efficient manner.

However the human capacity to learn has existed ever since humans have been on this planet and the needs have always been there even though previous societies have been less able to meet the needs than industrial societies. The difference is that the knowledge of how to meet the needs in a better and more efficient manner has not always existed. It has gradually accumulated over time. It is the increasing knowledge that is present in the change from hunter gathering to farming and pastoralism and then to industrial societies, that is absent from the preceding society. The knowledge required for industrial societies was not available in agrarian and pastoralist societies and the knowledge of how to domesticate plants and animals was not known to pre-historic hunter-gatherers as shown by my paper on the Discovery of Agriculture. Yet many of the needs of hunter-gatherers are the same as for modern humans. Only the knowledge of how to meet those needs is different between the various types of societies and this can be used to explain many of the differences between those different types of societies.

However the knowledge differences between those societies are not limited to knowledge of how to grow crops and herd animals and of various industrial processes. Agrarian societies usually have a knowledge of writing, metallurgy, transport (e.g. sailed and wheeled), and mathematics and in many other areas that does not exist amongst hunter-gatherers. Equally industrial societies have a knowledge of scientific matters that does not normally exist in agrarian societies, except by diffusion, and in the one agrarian society modern science existed in, it was an agrarian society on the verge of turning into an industrial society. Indeed, it was the growth in the knowledge of science in Europe from the time of Galileo to the beginnings of the industrial revolution in late eighteenth century Britain that was the necessary precursor to the industrial revolution.

The changes from hunter gathering to agrarian/pastoralist to industrial societies were caused by changes in the methods used by humans to produce the goods and services that meet human needs. These were changes in the technology used by humans but behind the changes in technology were changes in knowledge. It was the changes in knowledge that caused changes in technology, which caused the historical development from hunter-gathering to agrarian/pastoralist and then to industrial societies. The idea that increasing human knowledge is a major cause of social, cultural and historical change can be traced back to Comte and J. S. Mill.

Properties and structure of the environment

Human knowledge is of course knowledge of the human environment. It can scarcely be of anything else. The objects in our environment, including ourselves, have certain properties which determine whether those objects are able to meet human needs or may be processed in such a way that they will meet human needs. The nature of human biology determines where we live and what our needs are. We cannot fly or breathe under water, so we live on the surface of the earth. We have a need for fresh water and as water is a heavy item, relative to human strength, we have spent most of our history living close to supplies of fresh water. We have a need for food and as this need is not as easily meet as other human needs, such as for oxygen, humans have spent a great deal of time and effort in searching for or growing food. It is only since the industrial revolution, in some societies, that the production of food has become a lesser part of human activity.

However it is not just human biology that determines how we live. The biological nature of the plants and animals in our environment determines which we live on and which we do not. Some plants are poisonous to us and some animals are too fast for us to catch. However the wide range of food humans can consume has allowed humans to spread over the entire planet. Some plants and animals may be relatively easy to domesticate, others cannot be domesticated at all. It is the property of some plants that they are capable of domestication that enabled the development of agriculture. Plants ideal for human consumption may be sown, fertilized, watered, protected from competing plants by weeding and will grow and provide the food necessary to feed human populations. Some animals may be domesticated and may serve as draught animals as well as their meat, hides and milk being utilized to meet human needs. If plants and animals were incapable of domestication or, if domesticated, they were not able to meet human needs, then they would not have been domesticated and human history would be quite different.

A further determinant of how humans live is the properties of non-living matter that makes up the human environment. It is because wood and flint can be easily manipulated and altered, by chipping in the case of flint and breaking or cutting in the case of wood and because they are hard and can be made sharp that they have been important materials for tools and weapons. Materials such as bone and ivory have similar properties and have also been used for such purposes. It is the properties of some metals, such as hardness, malleability and that they can be mixed together to produce alloys, such as bronze and steel, that allowed them to supersede wood, flint, bone and ivory as the principal material for tools and weapons. If these materials did not have the appropriate properties they would never have been used to make tools or weapons.

Order of discovery

Human knowledge of the properties and structure of nature is acquired in a particular order. Certain things will necessarily be discovered before other things. Fire had to be discovered before metallurgy, as it is a necessary part of the metallurgical process. Copper was inevitably the first metal to be extensively used by humans, as it has a relatively low melting point. This meant it could be more easily released from its ores and shaped and reshaped than other metals. However the working of copper requires a furnace and molds so that inevitably it could only be done by a sedentary people. It is obviously not practicable for hunter-gatherers to carry round furnaces and molds. This meant that metallurgy could only develop after the domestication of plants and animals. The occasional example of sedentary hunter-gatherers, such as those on the north-west coast of America, do not seem to have developed metallurgy probably because their sedentary life style was a temporary result of a low population due to diseases from Europe spreading across America. Copper is a soft metal which limits its uses; a much stronger metal, bronze, can be made by mixing copper with another metal such as tin. Inevitably bronze was discovered after copper, as the use of copper is a necessary part of the manufacture of bronze. Bronze could not be made without the earlier discovery of how to produce copper and tin. The next metal to come into common use was iron. Iron has a melting point of 1535°C, about 500°C higher than copper. This means a bellows is required to produce the necessary heat for the smelting and working of iron. Inevitably the metals that could only be worked with a bellows only came into common use after the invention of the bellows. They would also only come into common use at a later time than the use of such metals as copper and bronze, which did not require the use of bellows. Iron came into use after bronze, as the process of creating an alloy is a relatively simpler process than the creation of heat of 1535°C which is required to work iron. Iron was followed by steel an alloy of iron and carbon. Obviously steel could not be made until after it had been discovered how to work iron, as iron is a necessary part of the production of steel.

The process of one thing necessarily being followed by another, either because the earlier thing is a necessary ingredient in the later thing, or because the earlier thing requires a simpler technology, such as fire with a lesser heat, can be seen throughout the history of science and technology. Inevitably, the steam engine had to be invented before it could be given rotary motion, and it had to be given rotary motion before it could drive the new machinery being developed in the industrial revolution and steam locomotives and ships. The sedentary lifestyles produced by the agricultural revolution were a necessary part of a great host of scientific and technological discoveries. Permanent buildings, metallurgy and writing are just three of the more important developments that would not have happened without the prior development of sedentism. The domestication of animals was a necessary pre-condition to developments such as wheeled transport and plough agriculture. The discovery that the earth and other planets orbit the sun could not be made, or at least confirmed, without the prior invention of the telescope. Without the telescope there would have been insufficient information about the movement of extra-terrestrial bodies to support the heliocentric theory. The development of more complex mathematics such as calculus and differential equations was necessarily dependent upon the earlier development of number systems and simple operations such as addition, multiplication, subtraction and division. The discovery of electricity had to take place before electrical heating and lighting and computers. The splitting of the atom by Rutherford had to take place before the development of nuclear power and nuclear bombs. These are just a few of the more obvious examples of the way in which certain discoveries or inventions could not have been made without prior discoveries or inventions being made.

A list of studies made by me investigating the order of discovery by humans of the world around us is, the invention of stone tools, the history of metallurgy, the history of astronomy, the history of electricity, the history of writing and record keeping, the history of medicine, the discovery of the periodic table, the discovery of steam power and the discovery of the atomic world. There are many other areas of history where the order of discovery could be studied such as the history of mathematics, the history of building and architecture, the history of computers and the internet, the history of economics, the history of accounting, the history of warfare, the history of railways, history of music and the history of ships, history of the telescope, history of the microscope. Many of these areas of study could be sub divided for example the history of warfare could be divided into areas such as the history of artillery, history of tanks, history of submarines and the history of the machine gun. The history of ships could be divided into the history of galleys, history of sailing ships and the history of steam ships.

Ease and difficulty of discovery

The order of discovery of human knowledge of the environment is determined by how easy it is to make that discovery. What determines whether a discovery is easy to make or more difficult? If there is direct sensory experience of something then the discovery of that thing is fairly easy. There are many examples of this. We have direct sensory experience of air for example with the wind, leading to it being included within the four elements of ancient Greek philosophy. Yet there is no direct sensory experience of oxygen and nitrogen in the air as these gases are colorless, odorless and tasteless and make no sound or cause any feeling distinguishable from the air as a whole. It was not until the late 18th century that oxygen and nitrogen were discoverable as a result of a series of experiments carried out by scientists such as Lavoisier, Priestly, Scheele and Cavendish.

A further factor in whether a discovery is easy or not depends upon whether other prior discoveries need to be made before the discovery is made. In metallurgy, native metals, which do not have to be separated from an ore, were used earlier in history than metals from ores as it was not necessary to discover a prior smelting process to get the metals from their ores. A further example from metallurgy is that copper metallurgy developed before iron metallurgy as copper could be smelted using an ordinary kiln, while iron smelting required higher temperatures than copper smelting so a kiln with a bellows was necessary for iron smelting. Iron smelting required the prior discovery of a kiln with bellows before it could be developed.

Many modern inventions and discoveries required a considerable number of prior inventions before they could be made. A modern personal computer would have required discoveries such as electricity and how to control electricity, how to control electrons in a computer monitor, discoveries in metallurgy and in the production of plastic materials and developments in mathematics and computer programming before its invention. The prior inventions of writing, printing and keyboards were also required while in mathematics the invention of a number system, simple operations such as adding, subtracting, multiplication and division and the invention of binary number systems were required for the invention of the modern computer. The list of discoveries required prior to the invention of the personal computer is enormous and ultimately goes back to the discovery of fire.

Multiples

A lot can be learnt about the order of discovery of things in our environment by a study of the phenomena of ‘multiples’. Multiples concern the multiple and independent discovery of the same scientific idea or invention by more than one scientist or inventor. Considerable work was done on multiplies by William Ogburn and Dorothy Thomas who established a list of 148 independently duplicated scientific and technological discoveries. They suggested these discoveries became virtually inevitable as knowledge accumulated within any given society and the needs of that society caused attention to be directed towards problems associated with meeting those needs.

The history of science and technology provides many examples of multiples. Some of the better known examples are:

1. Agriculture and the domestication of animals were invented independently in the old world and the new world. It may be there were a number of independent inventions of agriculture and the domestication of animals in both the new and old worlds. It is likely that agriculture was an almost simultaneous yet completely independent development in South West Asia, China, South East Asia, Mesoamerica, South America and the Eastern United States.

2. Calculus may have been invented independently by both Newton and Leibnitz leading to conflicting claims as to who was first. However it may have been the case that Leibnitz had seen Newton's work before it was published.
3. The theory of evolution was invented separately by both Darwin and Wallace. Both had read Malthus's *Essay on Population* and had been studying flora and fauna in Darwin's case in the Galapagos Islands and in Wallace's case in Burma.
4. The periodic table was proposed by Mendeleev in 1869 and a year later a similar idea, developed independently was put forward by Lothar Meyer.
5. The discovery of oxygen was made by Carle Scheele in 1771, but his work was not published until 1777. Joseph Priestly independently discovered the gas in 1774 and informed Antoine Lavoisier and both Priestly and Lavoisier continued to work on the gas until Lavoisier concluded the gas was a separate component of air.
6. The discovery of Neptune was made independently by Adams and Leverrier in 1846.
7. Genetics was discovered by Mendel in the 19th century and then independently by Hugo Marie de Vries, Erich von TSchermak and Carl Correns in 1900.
8. Non- Euclidean geometry was independently invented by Carl Gauss, who did not publish his work and the Russian Niolai Lobachevsky in 1829 and by a Hungarian Janos Bolyai.
9. The wave theory of light was developed independently by Thomas Young in England and Augustin Fresnel in France.
10. Visual pigments were independently discovered by German physiologists Franz Boll and Wilhelm Kuhe.

There are many more examples of multiples; Robert Merton came up with 264. Merton considered that the pattern of independent multiple discoveries in science is the dominant pattern of scientific discovery and that discoveries made only once in science, known as singletons, are the more unusual case.

Robert Merton suggested that multiples show discoveries are inevitable because if one scientist does not make the discovery, another one will. This was also the view of Ogburn and Thomas and has become the standard interpretation of multiples. This suggests there is an inevitable element in the progress of science and technology, so long as it is not interfered with by external forces such as governments and religious authorities.

Multiples also suggest that discoveries are not only inevitable, but that they must take place in a particular order. Thousands of years of human history may go by, without something being discovered, and then several scientists or inventors make the same discovery at the same time. This suggests that certain prior developments were necessary before a discovery can be made. Only when those prior discoveries have been made is it possible for certain later discoveries to be made.

The existence of multiples is exactly what would be expected if there were a specific order of discovery for science and technology. A particular scientific fact or technological achievement may remain uncovered for thousands of years and then be discovered separately by two or more individuals, suggests it could not have been discovered until certain other scientific facts or technological achievements had been discovered. It also suggests that when those other facts and achievements have been uncovered, then the discovery of further scientific facts and technological achievements will be almost inevitable. This however is conditional upon the state of society being conducive to scientific and technological discovery. In particular there should be no institutions, such as church or state interfering with the process or communication of the discovery.

Effect of increasing human knowledge on society

Ever increasing human knowledge is the ultimate cause of the development of human societies from hunter gathering to agrarian to industrial societies. However as human societies change from one form to another, there are substantial changes in the social and cultural institutions of those societies. The different types of societies tend to develop with different population structures, class systems, belief systems, government and legal systems, and different types of economies. The changes to these social and cultural systems are dependent on the prior changes to technological systems and so occur in a particular order as the technological changes occur in a particular order.

Hunter gathering societies tend to be nomadic, to consist of bands of a few dozen people related by kinship and all of the same ethnicity and language. Their form of government is usually egalitarian, without bureaucracy and with no monopoly of force and with informal conflict resolution. They have no food production or surplus, the division of labor is limited to age and gender and land control is limited by the bands nomadism. Hunter gatherer societies tend to be egalitarian, do not have slavery and there are no luxury goods available for the elite. There is no public architecture or literacy.

Agrarian societies are sedentary with most of the population, which can number in the millions, living in rural areas. The societies are class based and may consist of more than one ethnic group and language. The governments are usually hereditary, centralized and bureaucratic, and have a monopoly of force, and dispute resolution is usually by law and judges. Food production is the most important area of the economy, although there can be occasional shortages. The division of labor is much greater than in hunter gatherer societies. The land is controlled by the ruler and aristocracy and the society is highly stratified, with forced labor such as slavery or serfdom common, and the elite has considerable access to luxury goods. Public architecture and literacy normally exist in agrarian societies, although literacy is not widespread.

Industrial societies, populations are sedentary, urban and normally number in the millions. The relationship between members of the population is based on class and residence. Industrial societies can have more than one ethnic group and language and governments are usually centralized and democratic. There are many levels of bureaucracy and governments claim a monopoly of force and conflict resolution is usually through law and judges. Industrial societies are usually secular and scientific with religion having a significantly lesser influence than in agrarian societies. Food production is a minor area of the economy and usually there are no food shortages. There is an extremely high level of division of labor. The control of land is spread amongst the population, but unequally, and society is stratified by class, although there is no slavery. Luxury goods are available and there is substantial public architecture and literacy is widespread.

It is quite clear that certain social and cultural systems are much more clearly associated with certain technological states than others. There is no reason in principle why hunter-gatherer bands should not be ruled by hereditary monarchs, but they never are. Equally, there is no reason in principle, why agrarian states, especially if they are not excessively large, could not be democratic, but they hardly ever are. Rather hunter-gatherers usually have informal egalitarian leadership and agrarian states are usually ruled by hereditary monarchs. There is a disproportionate co-relation between certain technological states and the type of social and cultural systems that accompany those technological states.

It is the disproportionality that needs explaining and the explanation is provided in this paper. There are cases where modern technology exists in some societies but the social and cultural changes have not taken place. However these societies are in the process of changing and over time will change. Not all modern industrial societies are democratic, but those that are not, are in the process of becoming democracies. Fifty years ago there were very few democracies, now most governments are either democracies or pretend democracies, where they hold elections but where the government is almost certain to win. There has been a tremendous diffusion of technology over the last one to two hundred years and the social and cultural change takes a while to catch up with the technological change, but it will eventually do so. This paper is concerned with long term changes to societies, not the short term situation where modern technology is introduced to agrarian societies and the social and cultural systems of those societies takes time to catch up.

The important point is that changes in human knowledge cause changes in technology and through the effect that technology has on the social and cultural systems of a society, the change in human knowledge will affect all elements in that society. Changes in human knowledge may also directly affect the social and cultural systems in human society. Ideas such as biological evolution and cultural relativity have affected human society, without producing any technological innovations. Human history in all its elements will be affected by the increase in knowledge that gradually accumulates in human culture.

It is necessary to describe not only why societies and cultures have certain similarities, but also why they differ one from the other. Many of the differences are a direct result of differences in the physical environments occupied by the various societies or cultures. Societies or cultures located in the artic or in temperate zones or in the tropics will all be different from each other, as will inland groups and coastal groups and groups in areas of good rainfall will differ from those in deserts. Such differences will be much greater among agrarian and hunter-gatherer societies located in different environments, than between industrial societies located in different environments. This is because hunter-gatherer and agrarian societies are much more dependent on the immediate physical environment than industrial societies. The behavior of powerful individuals can also cause societies to differ from each other, but these changes will usually not be long term. The rise and fall of Nazism and Communism are examples of such temporary societies.

Guttman scale analysis

The idea that societies acquire social and cultural traits in a particular order is also shown by Guttman scale analysis. Guttman scale analysis is a method of assembling data that can show the order in which social and cultural traits were acquired. Where repeated over a number of societies it can suggest there is an order of acquisition of traits that commonly occurs and occurs far too often to be regarded as a statistical coincidence. The method of Guttman scale analysis is explained in my paper Guttman Scale Analysis and its use to explain cultural evolution and social change. Guttman scale analysis has been carried out in a number of studies to examine the order in which societies acquire social and cultural traits by Robert Carneiro and most recently by Peter Peregrine and Carol and Melvin Ember.

The Peregrine-Ember study looked initially at eight social and cultural traits being inter-societal trade, subsistence economy based on food production, social stratification or slavery, full-time government specialists, full-time craft specialists, political states of 10,000 in population, towns exceeding 1,000 in population and writing. Using scale analysis Peregrine and the Embers concluded that the scale analysis suggested there were general sequences in cultural evolution and a comparison of how these traits developed in eight societies being the Yellow River Valley, Nile River Valley, West Africa, Mesopotamia, Indus River Valley, Highland Peru, Lowland Peru and Highland Mesopotamia confirmed the conclusion of general sequences in cultural evolution that applied to a wide variety of societies.

Only eight traits were used for the study, so, to avoid the possibility of chance affecting the results, a further study was made using fifteen traits. Those traits in order in which they scaled and in which societies developed them were ceramic production, presence of domesticates, sedentarism, inegalitarianism, population density of more than one person per square mile, reliance on food production, villages of more than 100 people, metal production, presence of social classes, towns of more than 400 persons, states of 3 or more levels of hierarchy, population density of more than 25 people per square mile, wheeled transport, writing and money. The sequence in which these traits were developed was compared in the same eight societies used in the first study and the results showed very similar scaling between those societies indicating a universal pattern in cultural evolution. The scaling was not perfect, for example in five of the eight sequences ceramics was not present before domesticates, but the overall results show a pattern that was not random and could not have arisen through chance.

Robert Carneiro made a more detailed series of studies of a larger number of traits and societies, using scale analysis, than was used in the Peregrine-Ember studies. These studies consistently showed societies developing traits in a particular order that could not be explained by chance. One study involved fifty traits ranging from special religious practitioners, the most common trait, to the least common which was temples extracting tithes. The societies studied ranged from the aboriginal Tasmanians, the society with fewest traits, to New Kingdom Egypt. The scale analysis showed that societies with the most traits had the same traits as the other societies, plus additional traits and the most common traits existed in nearly all societies. This by itself does not show sequence but Carneiro then compared thirty four of the traits whose order of development could be identified in Anglo-Saxon England with the order of development suggested by scale analysis. The comparison resulted in 84.9% of the traits in Anglo-Saxon England arose in the order suggested by scale analysis, while 15.1% did not. Such a result, given that historical information may not be perfect and that scaling may be effected by the description and diffusion of traits, suggests the order in which traits were acquired was not random. Carneiro made further studies involving a comparison of two traits such as agriculture and cities over many societies and found, not surprisingly, that agriculture preceded cities in every case. A similar comparison involving taxation and sumptuary laws found that while neither trait was very common in the societies studied, indicating they were developed later in time, sumptuary laws always followed taxation, indicating a definite order of development. Caneiro also studied cases of differential evolution where evolution within one area of culture develops independently of other areas of culture. He considered that as traits from a particular part of culture, such as political organization are more closely related to each other than they are related to other traits there will be a greater degree of scaling between traits concerning political organization than with other cultural traits. When Carneiro scaled the traits concerning political organization he found they showed a higher degree of scaling than was obtained by scaling all cultural traits together.

The results of the Peregrine-Ember and Carneiro studies indicate that societies develop cultural traits in a particular order. This is shown over a wide variety of traits and over a wide variety of societies. The results of the Guttman scaling show the accumulation of cultural traits is not random as random accumulation of traits would produce quite different results in scale analysis.

A map of the facts of the universe

A map shows the location in space of different places, such as countries, cities, streets and other geographic entities. If a person knows where they are located on the map they are then able to work out where they are in relation to other places and through what places they would have to pass to arrive at any other place. It should be equally possible to produce a 'map' showing where the facts of the human environment are in relationship to human beings and to all the other facts of the human environment. This is a direct consequence of the human environment having a particular structure and that human knowledge of the environment grows in a particular order with certain discoveries inevitably being made before certain other discoveries. Such a map will not show the location of facts in space, rather it will show their location in relation to each other and to humankind.

The basis of such a map is that some facts (say facts B) will not be obtainable without the prior discovery of other facts (say facts A). This means that facts B will lie beyond or are further away from us than facts A. Obviously the discovery of planets such as Neptune and Uranus would not have been made without the prior discovery of some means of observing them, such as the telescope. This is because they cannot be seen by unaided sensory observation. Equally metallurgy, pottery and glass making could not have been discovered without the prior discovery of fire, as fire is a necessary ingredient in metallurgy, pottery and glass making. The discovery of Neptune and Uranus lie beyond the discovery of the telescope or some other means of extending human sense perception and the discovery of metallurgy, pottery and glass making lies beyond the discovery of fire.

A further way of locating facts on such a map is where certain facts are relatively easily acquired, such as how to make fire, and certain other facts, such as how to do calculus, are less easily acquired. This is because the discovery of calculus is more complex than the discovery of fire. Calculus requires a number of prior discoveries to be made before it could be discovered. The knowledge of fire is not a pre-condition to the discovery of calculus, but calculus was always going to be discovered after the discovery of fire and so could be located on a map as being much further from human beings than the discovery of fire. Calculus would be located on a different line of development from fire, being on a line of development requiring the invention of a number system and the ability to do simple mathematics such as addition, subtraction, multiplication and division.

Certain facts are obvious to the naked senses. The four elements of classical Greece, air, fire, water and earth are obvious to the naked senses and are widespread in nature and so were the first explanation of the constituents of matter. Indian science had the same four elements as classical Greece. The Chinese had five elements being water, fire, earth, metal and wood. The difference between the Chinese elements and the Greek and Indian elements can be put down to neither theory being correct, the correct understanding of the constituents of matter being beyond classical Greek, Indian and Chinese science. Naked sense observations of matter were always going to produce theories like the Greeks, Indians and Chinese held but as there was no way they could produce a conclusive answer to the constituents of matter, the theories could always be a little different.

The traditional Greek view of fire, air, water and earth as the basic elements of matter continued to be at least partially accepted in Europe until the revolution in chemistry that occurred in the late eighteenth century. The decomposition of air and water brought about by the use of new scientific instruments and techniques lead to the modern concept of elements as matter that could not be broken down into constituent parts. Lavoisier's list of 33 elements, despite some mistakes, was the first modern list of elements. The list of elements was subsequently corrected and added to when new elements were discovered. Dalton's atomic theory suggested different elements were made up of different atoms and this explained the different properties of the elements. The eighteenth and nineteenth century concepts of elements and atoms could not have been developed without the prior decomposition of air and water which showed they were not elements but were made up of other substances. The discovery of the elements was necessary before the atomic theory, which explained the different elements as being made up of different atoms.

Atoms remained the basic constituents of nature until 1897 when J. J. Thompson discovered the electron. The nucleus of the atom was then discovered by Ernest Rutherford, which made a negatively charged electron and the positively charged nucleus the basic constituents of matter. The neutron was added in 1932 with its discovery by James Chadwick, so the basic constituents of matter were the proton, neutron and electron. In the 1960's protons and neutrons were discovered to be made up of quarks, so the smallest constituent parts of matter could be considered to be electrons and quarks. There is considerable current debate as to whether quarks and electrons are made up of tiny vibrating strings called superstrings.

There was an order of discovery running from the elements of ancient Greece, India and China, to the elements as discovered in the late eighteenth century, to Dalton's atoms, to the nucleus of the atom and electrons, to protons, neutrons and electrons, to quarks and electrons and possibly to strings. The particular order in which these discoveries were made was inevitable. This enables us to say that in some sense that those things we can see with unaided sense perception are closer to us and that successively, the idea of the elements, atoms, the nucleus and electrons, protons, neutrons and electrons and quarks and then strings are located further from us.

A similar situation applies in astronomy. The unaided sensory view is that the Earth is not moving and the Sun orbits the Earth. When more sophisticated observations were made of the heavens the Greeks created the Ptolemaic system with a stationary Earth being the center of the universe and being orbited by the Sun and the planets in circular orbits with epicycles being used to further describe the planet's movements.

The classical Chinese cosmology also considered the Earth to be motionless center of the universe with various theories of the Sun and the planets orbiting the Earth. The Chinese theory however differed from the Greek by not having the Greek geometric schemes of planetary motion. Indian cosmology also involved a stationary Earth orbited by Sun and planets and seems to have been as geometric as the Greek cosmology.

The Ptolemaic system survived in Europe, until Copernicus published his heliocentric theory and Kepler showed the Earth and other planets orbited the Sun in elliptical orbits. Kepler had the benefit of improved observations of planetary movements from Tycho Bathe and his theory could be confirmed with observations made using the newly invented telescope. The work of Copernicus and Kepler was ultimately completed by Newton with his laws of gravity and motion with the help of new mathematical tools such as calculus.

Observations of planetary motions continued to improve and it was observed that Mercury did not move in accordance with the Newtonian system. Eventually the Newtonian system was replaced by Einstein's theory of general relativity, which had the planets orbiting the Sun in circular orbits in curved space-time. Improved mathematical tools such as non-Euclidean geometry helped the establishment of general relativity.

The order of discovery from a motionless Earth orbited by the Sun, to the Ptolemaic and classical Chinese and Indian systems, to the Newtonian system, to Einstein's system was fixed. Each system gave way to its successor due to improved observations and/or mathematical tools. Each successive system can be considered to be further away from humankind than its predecessor so that the closest to humankind is the Sun orbiting the Earth, followed by the Ptolemaic and classical Chinese and Indian systems, then the Newtonian system, with Einstein's system being the furthest away.

It should be possible to create a "map" that shows where every fact of the universe lies in relation to human beings and in relation to every other fact. Such maps would show the various lines of development through which human knowledge of the universe grew and had to grow. They would show the order in which human knowledge of the universe developed which has a great effect on the type of society available to human beings.

The Challenge

An interesting factor in the proposed theory is that it enables human historical development to be studied scientifically and objectively. The natural sciences are the same for all societies on Earth, and they have an element of certainty or truth about them, which is not available in the social sciences. By tying human historical development to our discovery of the facts of the natural sciences, we are tying human historical development to the most well established facts we have available. This will provide a solid objective basis to any theory of human historical, social and cultural development based on the order of the discovery of the facts of the human environment.

Given the scientific and objective nature of the physical sciences it should be possible to construct a theoretical map of the facts of the human environment, such as they are known to us. This map should show which facts are closer to us and which facts are further away from us. Such a map may require some means of measuring how far particular items of knowledge are from us. This would involve an analysis of the complexity of the facts and in particular what prior facts would need to be known before the particular fact could become known to us. If this were done, you would have a theoretical order of discovery of the facts of the universe. This theoretical order could then be compared to the actual order of discovery of the facts of the universe in order to test the theory expressed in this essay.

In order to create a theoretical order of discovery and to compare it with the actual order of discovery it will be necessary to write a new type of history. Histories of science and technology are usually written in narrative form, copying the form of political and diplomatic history. If they were written so as to involve an analysis of the ingredients that went into the making of a particular scientific or technological discovery, then it would be possible to analyze the order of discovery, that led to the discovery of any particular invention or scientific discovery. This would provide a new insight into scientific and technological discoveries; an insight that is not apparent from simple narrative describing how one invention or discovery followed another invention or discovery. This would enable a complete description of the order of discovery made by humankind and would show all the intellectual and technological states humankind passed through in order to reach any particular intellectual or technological state. Such empirical studies could then be compared with a theoretical map of the facts of the universe to see if the order of discovery, suggested by such a map, has in fact been followed in the actual course of human history. Local environmental factors, chance and the activities of great men and women, in so far as they may be applicable, would need to be taken into account, but once this was done, it should be possible to compare, a theoretical order of discovery, with the actual historical order of discovery. If they match up, or discrepancies may be explained by local conditions, chance or the activities of great individuals, then the theory proposed may be correct. Such a procedure would amount to a test of the proposed theory, making it potentially falsifiable. Such a theory could be considered to be scientific in the same sense as biological evolution is scientific.

In conclusion, what can happen in social and cultural history is set for us by the structure of the universe, such as the laws of physics, chemistry and biology, the properties of the particles, elements, compounds and mixtures making up the material of the universe and the genetics of the living matter, including humans, in the universe. The course of social and cultural history, for example the sequence of events, is set for us by the order of discovery of the structure of the universe which is an order from the easiest to the more difficult or from that which is closest to us to that which is furthest from us. These two questions, what can happen in social and cultural history and the order in which it happens are two quite distinct matters that should be kept separate when studying social and cultural history, social change and cultural evolution.

The other significant feature of the theory expressed in this paper, is that it suggests a new way of writing social and cultural history and about social change and cultural evolution. It suggests it is possible to state not just <u>what</u> happened but also <u>why</u> it happened and why it happened at a particular point in time. An analysis can be done to show what the laws of the natural sciences and the properties of the material constituting the universe allow to happen in social and cultural history and the order in which the discovery of those laws and properties provides a sequence in social and cultural history and in social change and cultural evolution. This allows the study of history to be put on a much more scientific basis than has been possible in the past. This is because both what can happen in social and cultural history and the order of events are necessary and certain and become capable of rational explanation. They are not random or dependent upon human whim or decision making. This method of writing history could provide a new way of writing thesis, articles and books in history, sociology and anthropology.

Bibliography:

Alexander, William & Street, Arthur (1962) *Metals in the Service of Man*, Pelican Books, Harmondsworth, England
Balazs, Etienne (1964) *Chinese Civilisation and Bureaucracy*, Yale University Press: New Haven and London
Basalla, George (1988) *The Evolution of Technology*, Cambridge University Press, Cambridge
Braudel Fernand (1967) *Capitalism and Material Life* 1400-1800, Fontana, London
Cardwell, Donald (1994) *The Fontana History of Technology*, Fontana Press, London
Carneiro, Robert, Ascertaining, Testing and Interpreting Sequences of Cultural Development in *Southwestern Journal of Anthroplogy* 24 (1968) :354-374.
Carneiro, Robert, Scale Analysis, Evolutionary Sequences and the Rating of Cultural in *A Handbook of Method in Cultural Anthrology* ed byRaoul Naroll and Ronald Cohen, (Columbia University Press, New York and London, 1970) 839-841 and 843-845.
Crump, Thomas (2001) *A Brief History of Science*, Robinson, London
Daumas, Maurice (ed) (1964) *A History of Technology and Invention*, Presses Univesitaires de France
Dennell, Robin (1983) *European Economic Prehistory*, Academic Press, London
Diamond, Jared (1998) *Guns, Germs and Steel*, Vintage, London
Donagen, Alan & Barbara (1965) *Philosophy of History* New York
Durkheim, Emile (1984) *The Division of Labour in Society* Basingstoke
Fagan, Brian (1995) *People of the Earth: An Introduction to World Prehistory*, Harper Collins, New York
Federn, Karl (1939) *The Materialist Conception of History* London
Galtung, Johan & Inayatullah, Sohail (ed) (1977) *Macrohistory and Macrohistorians* Westport, Conn
Gardiner, Patrick (ed) (1959) *Theories of History* Glencoe
Gribben, John (2002) *Science: A History, 1543-2001*, Penguin Books, London
Grunger, Rolf (1985) *Philosophies of History* Aldershot, Hants
Harris M (1987) Anthropology and the Study of Culture in *Cultural Anthroplogy*, New York
Johnson, Allen & Earle, Timothy (2000) *Evolution of Human Societies: From Foraging Group to Agrarian State* Stanford University Press, Stanford
Lenski, G & J (1970) *Human Societies*, McGraw-Hill Book Co, New York
Lilley, S Technological Progress and the Industrial Revolution 1700-1914 in *The Fontana Economic History of Europe* ed C Cipolla, (1973)
Mertons, R (1973) *The Sociology of Science*, Chicago
Meyer, Jerome (1956) *World Book of Great Inventions*, The World Publishing Company, New York
Mill, J S (1872) *A System of Logic* London
Mokyr, Joel (1990) *The Lever of Riches: technological creativity and economic progress*, New York
Ogburn, W F (1922) *Social Change*, New York
Ogburn, W F & Thomas, D S, Are Inventions Inevitable in *Political Science Quarterly* 37 (March 1922)
Peregrine, Peter, & Ember, Carol & Melvin, Universal Patterns in Cultural Evolution: An Empircal Analysis using Guttman Scaling, *American Anthropologist* 106(1):145-149.
Popper, Karl (1957) *The Poverty of Historicism*, London
Price T. D. & Gebauer (1995) *Last Hunters-First Farmers*, Santa Fe, New Mexico
Rambo, A Terry, The Study of Cultural Evolution in *Profiles of Cultural Evolution* (1991) Ann Arbour, Michigan

Renfrew, Colin (1973) *Before Civilization*, Penguin Books, Harmondsworth, England
Sanderson, Stephen (1999) *Social Transformations: A general theory of historical development* Rowman & Littlefield Publishers, Lanham
Shaw, W F. (1978) *Marx's Theory of History* Stanford, California
Silver, Brian L (1998) *The Ascent of Science*, Oxford University Press, Oxford
Taylor, Gordon Rattray (1983) *The Inventions that Changed the World*, Readers Digest, London
Usher, Abbot Payson (1954) *A History of Mechanical Inventions*, Harvard University Press, Harvard
White, Leslie (1970) *The Science of Culture*, Toronto
Williams, Trevor (1982) *A Short History of Twentieth Century Technology*, Clarendon Press, Oxford
Zohary, Daniel and Hopf, Maria (2000) *Domestication of Plants in the Old World*, Oxford University Press, Oxford