(from gerry's writings, 29.4.98)

A SYNTHESIS OF THE WORK

1) A well established higher education system into which new learning can feed (notes - questioning, respect for learning, older and younger generation, rigidity).

2) A hierarchy which permits:-
a) an authority structure
b) competence to rise in the structure. Note Japan's interesting 2-tier structure age/ability on parallel tracks.
3) Manufacture must be economically beneficial compared to alternatives, i.e. service industry.
4) xenophobia?
5) A large (new?) market must already exist i.e. no market pioneering.
6) Re 5, note importance of textiles to kick 'start' the move to industrializations but only when other factors are present, i.e. rug weaving universal, but does not automatically lead to industrialization.
7) The whole process is transient - wealth, acquisition.
8) Cities must exist and act as attractions for large numbers of young men.
9) Role of the entrepreneur - he must see manufacture as desirable and he is less than 1% of the population.
10) Large injection of new data, technique needed over extended period.
11) Note difference and mode of transition from society which **absorbs** new knowledge and society which **generates** new knowledge
Phase lag - society which generates once absorbed. Hence networks.
12) Detailed examples from GWP compare Japan, USA.
13) Use looking-backwards approach - examine in great detail what's needed for knowledge generation knowledge dispersal, artifact manufacture with both tacit and coded knowledge in more complex society and see how this it is diffused to less complex.

Re 8. Large numbers of young men more to an area, with a prominent and existing market to seek careers. This will be widely recognized as a 'good job' place. The structure has to be in place to create the nucleus of such a place or places. The attraction is stronger for the more skilled and the more adventurous. But service industry must not be the main attractor. i.e. this must be either a small or newish centre for wealth generation and capable of rapid growth from a surrounding hinterland.
14) Consider the very delicate balance in a society between encouragement and disencouragement of innovation, i.e. large companies. Pressures to do things the same way.
15) Need for very detailed local new work to come into existence before local innovation can take off.
16) Cases to consider.

Diagram:

17) Consider the **existence** of an education system. **Why** did it come into existence? What does it show re the relationship between older and younger generations?
18) Read Hallpike?? 'Principles of Social Evolution Introduction and China', p.294. Awful jumble - he doesn't seem to know what he is trying to explain. Suggest stick to **artifacts** and **knowledge** needed to make artifacts.

19) Consider conditions required for **sustained** industrial activity over many generations (and sustained farming after H.G.) Importance of hierarchy and responsibility between generations.
20) Consider constantly the effect mentioned in Kuhn - internally consistent explanation within isolated group - like economies a form of logic that does not correspond to reality. (cf Einstein).
21) Cohesiveness of the group and rejection of outsiders. See newspaper article.
22) Lack of external predators, and low level of overseas aggression may have contributed to low innovation and low technology. Need to study relationship between innovations and warfare in Europe - see McNeill.
23) The mechanism of **overshoot**.
(new section)

The growth of Japanese industry during the last 150 years or so has been characterised by the acquisition of new (to the Japanese) knowledge from the west, and the use of this new knowledge to produce products.

Initially, the products were inferior to western products, then some of them became equal, eventually, a quite recent development a few have in some respects become qualitatively superior.

This is, initially, innovation of product was once wholly imported, then there was an indigenous innovative improvement, then, with a few products, innovation was exported.

This pattern follows very closely the growth of product manufacture in England 1500-1750, import coming largely from or through Europe.

However, there are important differences in the comparison - during the period of industrial growth in England, the techniques for the generation of new reliable knowledge were themselves being innovated, so:-
a) new date was becoming available to potential product and process designers (and this 'new data' was quite new - not available previously)
b) the systematic intellectual methods for the production of this new data started to diffuse into product design, so that design became more rational, more systematic, more experimental. (This second effect has been entirely overlooked by economic historians, yet is crucial to an understanding of the development of industry in the C18.)

Japan did not go through these phases of development.

In the textile industry, for instance, very extensive hand loom weaving built a successful base on low cost skilled, disciplined labour, then boomed by a combination of low cost skilled labour and automatic power looms imported from Europe and America and new synthetic fibres, also imported.

Gradually, powered automatic machinery was copied locally, and synthetic fibres were also copied.

This pattern has been repeated in many industries, and helps to clarify more exactly what changes we are trying to explain in 'Fertile land' studies.

Some of the characteristics which seem appropriate in this type of shift are:-

1) Large numbers of people, right across the spectrum of intellectual ability, must go into, and stay in the field of material manipulation.
2) Effective education systems must teach large numbers of people in a rationalistic thought mode, and disseminate factual data relevant to product design and manufacture.
3) There must be a 'work ethic'.
4) There must a hierarchy of a form which selects and encourages ability in all the various areas required in complex institutions and permits this ability to influence action in the appropriate parts of the

organization.
5) There must be an ethos of **diligence** pervading the whole.
6) Propensity for **frugality**.

Japanese product development can be viewed broadly as a parallel to Thomas Kuhn's 'normal science', rather than paradigm - shifting science - this is, design innovation takes place by rearrangement of data within existing conceptual spaces.

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I have written this very brief and vastly incomplete summary of the development of the microscope (as mentioned earlier I am writing a fuller account separately) to illustrate the great amount of variation required to produce advance in just one detail, albeit a crucial detail, in the great network that eventually led to microbiology, antibiotics, DNA, genes...

Even to advance knowledge on this detail, variation came from at least seven European countries, over a period of 250 years. Crucial inputs came from activities that were initially not connected with the microscope at all - competition for imported wine glasses!

The picture emerges of a vast network of activity - some theoretical, some craft, some technological, some commercial, much driven by pure curiosity (there were no commercial applications at all for the microscope, except as an aid to demonstrators, from its initial development around 1610 until about 1850).

Also, the variations are put into the network from a large number of geographic locations. This seems to correspond well with the idea of the 'conceptual space' suggested by Herbert Smith and expanded and explored by Maggie Boden and Dave Perkins. We create new ideas by rearrangement of data within our individual conceptual spaces. We continuously run into dead-ends, in which the data within our conceptual space is inadequate to have significant creative outcome, to produce meaningful variation to throw into the network. Logical thought cannot take us any further - there is not enough data to bite on. Experiment can help, but is necessarily rather tightly focused - what experimenter, faced with a desire for an achromatic lens system, but with no certainty at all that it would work, could embark on an extremely expensive search for a new type of glass, of whose desired properties he was only dimly aware, to produce an improvement in a product which no manufacture could specialize insufficiently to make a livelihood?

It is on such tenuous threads as this that the discovery of DNA depends. What seems to happen is that new data comes into our conceptual spaces from other minds and other activities operation in quite different cultural environments, so that their conceptual spaces have substantially different sets of data.

The need is for an abundance of intellectual technological and manufacturing activity operating in different centres, with sufficiently strong barriers around them to maintain their own cultural identity, their own special conceptual spaces, but with just enough leakage to provide a trickle of new data to the other conceptual spaces in the network.

Individuals working closely together tend to erode the barriers rather quickly, and common schools of thought develop - conceptual spaces become too similar and new data for creative variation dries up.

If what I have described bears any relationship with reality, it goes some way to providing an explanation for the presence or absence of scientific activity in a society. The problem becomes one of creating a sufficiently large and varied network, intellectual, technological, manufacturing, to sustain itself. Above a certain level of activity, a certain abundance of conceptual spaces, boundaried but leaking, the creation of new 'reliable knowledge' can proceed. Below this level, it will atrophy. You can have spurts of local activity, such as astronomical clocks or magnets in China or seed selection in Japan, and these activities can flourish for a while until the possibilities resident within the conceptual spaces involved are exhausted, and then they will die away.

The conditions required to obtain the size and variability of network needed to be self sustaining are evidently vary rare, and I'm not a sufficiently good medieval historian to have much confidence in my ruminations, so I offer them solely to invite correction.

The mechanism for the creation of a large, diverse network, with leaky barriers between the various networking units may well have been the translation of Arabic and Greek texts into Latin in Europe between 1000 AD and 1200 AD. These made available to scholars from many parts of Europe a great deal of the scientific thinking which had occurred during the previous fifteen hundred years - intellectual and technical activity which seems to have arisen in circumstances rather similar to the Chinese science activities, in which there is a cluster of activity but without a sufficiently developed network to sustain it. Islamic scholars had brought this together (but not including Chinese work) and had translated it into Arabic.

I have made some little diagrams to represent sustainable and unsustainable situations, with a suggestion of how the most notable 'sustained' situation - W. Europe since 1000 AD may have occurred.

Diagrammatic representation of knowledge producing activity.

Diagram:

1) Single centre of activity. Soon runs out of new data, activity terminates.

Diagram:

2) Few centres of activity. Ultimately unsustainable, eventually terminates.

Diagram:

3) Many centres of activity. Sustainable, grows to scientific revolution. Problem. How do you start with many centres?

Diagram: Possible solution to problem.

E.L. Jones in 'The European Miracle', provides a very persuasive explanation of the unusual growth of the manufacturing economy in Europe, relating it to the great diversity of smallish societies in contact with each other and interacting in a complex network.

I have suggested a mechanism for the growth of science which equally depends on an abundance of boundaried but leaking groups.

A great difference between England and Japan is that England has been part of this large network, although on its outermost fringes, for two thousand years; Japan for little over a century. In the Achievement Project, specialists in a variety of artifacts - textiles, glass, agricultural products, weaponry, metals - have traced thought the history of their adoption and development in England.

The pattern is remarkably consistent. The artifacts were first imported from the European mainland. A local market developed - often a luxury market, and local manufacture was commenced, frequently with some sort of state assistance win the encouragement of foreign specialist workmen or in the granting of monopolies.

Developments made abroad were imported into this country and incorporated in local manufacture. This seems to have been the picture of English industrialization for over three hundred years, until around 1700 to 1750, the balance started to tip; England an importer of innovation fairly rapidly began to innovate, and soon became a major importer of innovation back into the European network and, by that time, the North American colonies.

The culture and economic circumstance of England (and I think we must include Scotland) have provided extremely fertile ground for a phase of economic growth. Exactly the same pattern is shown in Japan, but, with a more dramatic differential between Japan and the western economies, and with revolutions in transport and communication on a much compressed timescale.

The comparisons you are drawing between Japan and England are, in my opinion, very real and meaningful, but they are comparisons of cultures an economic patterns which provide fertile ground for economic and scientific growth. The seeds planted in this growth come mainly other parts of the network, and in the absence of the network there would not be enough seeds for growth to occur.

I have suggested in these notes some conditions that may be appropriate to the acquisition of knowledge - science - under sustainable or unsustainable circumstances.

It could be useful to consider the implications of this for the growth of industrial capitalism, and the breakthrough from commercial to industrialism.

I take it that the potential for commercial capitalism - the exchange of goods and services, with the expectation of some benefit - profit - by both buyer and seller - is universal, and where it is absent it is because of traditional or legal constraints that inhibit the production of goods or services to exchange, or inhibit the process of exchange, or confiscate the profits of exchange.

Industrial of manufacturing capitalism is much more complex, and it may be useful to try to divide it into its component parts.

We can envisage an industrial capitalism in which the artifacts exchange are of a craft nature, embodying only a very low rate of innovation, and this innovation when it does appear being mainly decorative or, if functional incorporating quite small improvements of knowledge.

A second form of industrial capitalism would have a larger rate of innovation affecting the function of the artifact (it is important to differentiate between functional and decorative innovation), but with the innovation coming from outside the society which is making the artifacts - that is, from the network with which the society is interacting. The implications are clear - no network means re-innovation.

A third form of industrial capitalism would have a large rate of innovation affecting the function of the artifacts but with that innovation being generated largely within the same society.

This third form is the one we associate with Golden Ages, with bursts of economic activity and relative success in comparison with surrounding societies, when a particular society is exporting back to the network more innovation than it is importing.

The third form seems always to develop through the second form, it seems to be always transient, and it seems, in its innovations, to incorporate new knowledge.

If this observation is correct, and if the explanatory model for the acquisition of new knowledge is correct (the need for an abundance of interacting or networking centres, boundaried so that can maintain integrity of their conceptual spaces but leaky so that data can pass to other boundaried conceptual spaces, and a non-lineal, bi-stable situation related to the number of separate conceptual spaces in the network) then we can see why Japan and other societies with advanced commercial capitalism could not proceed to the second or third forms of capitalism described above, until they become part of an existing knowledge producing network.

All this raises a host of questions. What are the conditions for 'fertile ground' for forms two and three? I suspect that they are largely the forms you describe, plus insertion into a large network.

What are the conditions for the creation of the abundant, boundaried intellectually oriented groups needed to produce the science network?

Why does form three, innovative industrial capitalism revert to predominant commercial capitalism?

How do entrepreneurs emerge in each of these three forms?

How dependent are the networks to the rate of creation of new knowledge and to the rate of interchange of data.

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These are stories of widespread activity from a very diverse range of cultural backgrounds, dozens of intellectual and economic networks interacting in a supremely fruitful way.

Italy, Flanders and Holland, Germany, France, England, Switzerland, Russia and Sweden have all figured as sites in this chaotic burst of creativity which created the microscope. The microscope is just one specialized artifact among the thousands that comprise our material culture, but all the others - automobiles, drugs, the great range of electrical equipment we use, computers, plastics - they and many more are the products of this diversity-driven process. Every European cultural region has provided innovating minds which have contributed to the development of our various functional artifacts. Refugees brining with them that peculiar propensity to innovate so characteristic of their type, amateurs pursuing sheer interest and curiosity, merchants moving goods between cultures, the new breed of professional scientist/educator generating reliable knowledge, humble craftsmen and tradesmen making lenses, tubes, gears and castings - all part of this process. Collectively they **are** the process.

Cultural diversity is the engine that drives the innovative process along. Uniformity leads to stagnation because there are no new ideas flowing into the network. Isolated islands - even large ones like Japan settle into uniformity; on land we look for remote villages to witness an unchanging past. Japan is an instructive case to study.

Some degree of geographical remoteness, reinforced by long periods of strict politically imposed isolation, had left it, after 250 Tokugawa rule with an economy that could truly be called commercial capitalism; free trading, banking, high literacy and a broadly based education system, agricultural sufficiency, a meticulously clean culture with little epidemic disease.

It puzzled many nineteenth century European visitors - it had many of the characteristics of a European country, set in an Eastern sea. What it lacked notably was the capacity to generate new reliable knowledge; its products, which were well made and of great variety, were all craft products, requiring solely craft skills in their manufacture. There was very little product innovation, practically nothing that could be called technical innovation.

Within less than a century after, in effect, membership of the chaotic network of Western Civilization, Japan is innovation prolifically and producing new reliable knowledge at a growing rate. Previously, it had been a homogeneous culture. The remarkable transformation came with immersion in the pool of cultural diversity.