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Introduction :
Four Commonly Accepted Tales
About Science, Technology, Society and Progress

Welcome to HPSC 1400. We believe this course is going to change the way you look at things--at the way science and technology work, at the ways society shapes science and technology and vice versa. **What we find is that most people, even very well informed and intelligent people, have a great deal of trouble penetrating the images and popular pictures of what science and technology are in order to get a good critical grasp of how they function as human institutions.** If you bear with us for the next thirteen weeks, a new world of understanding may begin to appear on the horizon and a small initial effort will eventually become quite useful to you.

History and Philosophy of Science [HPS] is not a single discipline; it's a cluster, a constellation of disciplines--such as history of science, technology policy, sociology of science, philosophy of science, economics of technological innovation etc. Some Universities don't have an HPS Department, but they do have a Department of Science and Technology Studies, or a Department of Sociology of Science; or a Science and Technology Policy Unit, or a Department of Environmental Studies and Policy.

HPS is an umbrella term for a number of disciplines. There are certain disciplines that focus on the study of science: History of Science, Philosophy of Science, and increasingly Sociology of Science and Science Policy. On the technology side we have the Politics and Sociology of Technology, History of Technology, even Philosophy of Technology, as well as the very important area of Technology Policy. Increasingly, issues in Environmental Studies, Policy and Management are coming to the forefront of our field. In short, HPS is a vast canvas of very rich overlapping and increasingly intersecting set of quickly changing disciplines.[1] **All of these fields have been brought together into the domain of History and Philosophy of Science to enable us to apply techniques of social science and humanities in order to understand science and technology as human, social, political institutions with complicated histories and relations to the rest of society.**

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[1]As for my own location in all this, I am an historian of science; I am trained in the history of science and the relevant context of European social and economic history. I also have training in philosophy of science and enormous amounts of professional retraining in the sociology of science.

Clearly, then, HPS is not a natural science discipline -- it is a *social science* or *humanities* discipline--it does not teach you science. If you want to become a scientist, you had better join a science department. Nor is HPS an engineering or technological discipline. As previously mentioned, it is a *social science* or *humanities* discipline--we do not teach you engineering or subjects of a technical matter. If you want to become a skilled practitioner of engineering, you had better join an engineering department. Now, because HPS is a *social science* or *humanities* discipline, we do exactly what other people in the social sciences or humanities do: Everyone engaged in the social sciences and humanities studies some sort of human activity or human institution -- it could be politics, art, the economy, the military, literature; or, it could be science and technology-- and we do so to enable us to discover where it comes from, how it works, how it shapes history and how it affects society.

In the field of HPS, we study the human institutions of science and technology; these are our objects of study. We do not study nature. We study scientists studying nature. We do not make or sell technologies -- we study the people who make and sell technologies. This may sound merely 'academic', in the same way that all of the social sciences and humanities can be labeled as not being terribly relevant, or as not being capable of producing worthwhile knowledge. **Yet we know things about science and technology as social institutions that have been shaped by society and in turn have affected society that the average practitioner -- the average scientist, engineer or technologist -- doesn't know about and these are real issues in our society, perhaps the key issues in fact.** For example, even if you know or care nothing about HPS, you cannot be alive in the late 20th century without realising that the issues concerning the impact of technological and scientific change on society are highly relevant and timely. A glance at any newspapers will show that they are filled with medical, scientific, technological and environmental controversies all with economic, political, moral and personal dimensions. **It is the job of HPS to study these social and human dimensions of scientific and technological change and to help educate people about these issues and how to analyse them.**

This is precisely where the issues of relevance and motivation come into the picture: Yet why should we do this? Is it necessary or possible to study the social dimensions of science and technology. What is there really to know about science and technology as human institutions, as activities with histories, as endeavours that are shaped by social contexts, and that in turn help form and sustain those contexts? You see, most of us think we understand science and

technology; that we know all there is to know about them; and that what there is to know about them can hardly depend upon what historians, philosophers, sociologists, economists and psychologists say about them. For, at least as far as most people are concerned, the fact of the matter is that science and technology seem simple to understand in their human terms: they are just 'natural', just what smart people produce in labs and research sites if they are left alone to get on with the job of applying scientific method. There is little that is social, historical or political about science and technology, at least not properly practiced science and technology, when they are not 'biased' or abused by such 'outside' factors.

I am therefore sure that many of you, whether you are studying the natural sciences or arts, engineering or social science, will tend to say, **what's the fuss-- don't science and technology have their own inner, rational logic, their own inner dynamics of development--what is there to study from the outside-- from a social science and humanities point of view?** After all, many of you may believe that science and technology operate best in a social and political vacuum; everything important and relevant about science and technology is in the technicalities, the particular theories and techniques--assuming scientists and technologists are properly funded, well trained, and left alone--science and technology should develop independently and take us down a path of progress.

Years of teaching and researching, of talking to students, and of observing common sense views in our society, and in our media, lead me to believe that many of you will be agreeing with the sceptical view I have just outlined. **Many of us do believe in this rather pure, apoliticial, ahistorical somewhat 'ahuman' picture of science and technology.** But, we shall argue in this chapter, and indeed throughout this subject, that is just a picture, a popular one indeed, and one of great lineage--it is after all over 300 years old. It is a picture, a cultural story--**But I stress the concept we are discussing here is that the reality of science and technology as social and human endeavors is much more interesting, and relevant, therefore open to study, than such a picture allows**.

Now, even without performing any great detailed analysis I think I can shake the idea that there is little for us HPS scholars to study. If that were really so, why are the world, our media and our consciousness increasingly dominated by environmental and technological controversies, by ethical and human dilemmas in medicine and ecology, and by public disputes amongst scientific and technical experts? **Some of you may even be enrolled in this subject not because you subscribe to the picture I painted above, but because you hold**

quite opposite beliefs. I am also sure that at least a minority of you are here today because you are aware of the existing social, political, ethical, economic controversies and dilemmas surrounding issues of: health; medicine; biotechnology; technological change and work; or the issues of pollution, development and the environment. For some of you at least it will already be obvious that these institutions of science and technology seem today deeply enmeshed in, shaped by, and consequential for all dimensions of our lives; the personal, the familial, the economic, the political and the environmental.

Let me make clear that I am speaking to both groups of likely listeners: those who do not quite see what the social and human aspects of science and technology can be, and those who are already sensitized to these particular issues. I really hold quite a neutral position between these groups, because I think both groups need to be exposed to a serious, sustained, scholarly, social, historical and political analysis of science and technology. **I do not think that possessing an already developed 'social conscience' about science, technology or the environment, necessarily means you really know anything about the social analysis of these things--and neither do I think that just because you do not yet credit the existence of social and human aspects of these things, that you cannot benefit from this subject--you may very well have your eyes opened in new critical and decisive ways!**
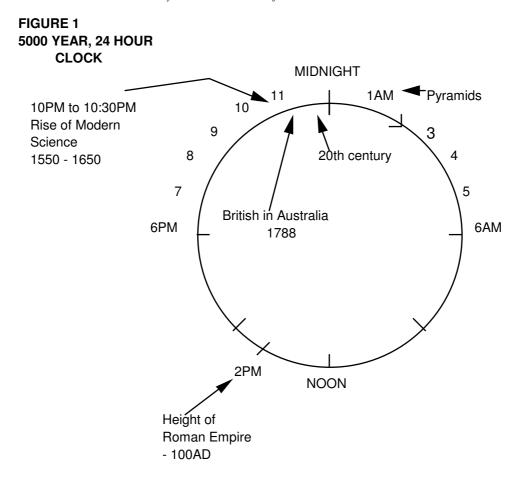
I wish to start by performing a thought experiment that explores the question of whether modern science and technology have any serious social and human aspects to be studied. To do this experiment we shall proceed as though we really believe the idea that Western science and technology are natural and self-explanatory: That smart guys sooner or later would have made just exactly the same scientific and technological discoveries that we have and in the order we have developed them. In other words we pretend that we take the view of our first majority group, who think there is little to know about the human and social aspects of science.

In doing this experiment I want you to keep in mind an important idea that follows the majority view of scientific development. Since Western science and technology are 'natural' to humans--at least to intelligent, objective, honest Western humans, then those cultures and societies that have not had modern western science must be, or have been 'dumb', or irrational, or biased, or somehow stunted in their historical evolution. That's the corollary of the majority picture. My experiment consists in examining the manner in which

this idea gained precedence by asking just how much of human history, human experience and human achievement has become tied up with modern Western science and technology.

Consider first our society, meaning Western society as a whole not stopping to differentiate its European, North American, Japanese or Australian variants. Now, consider that our society, based as it is on modern science and technology really is not 'natural' or 'inevitable'. Consider that within the whole spectrum of human societies in historical time and global space our society is actually pretty bizarre as societies go. Consider the idea that it is an unusual society in need of explanation and investigation and the main reason for our society's oddness is its unusual and recent reliance on science and technology. The way to work toward appreciating our oddness as a science and technology based society is to remind ourselves dramatically of a few things about human history, in particular ancient history.

Figure 1 is a clock--an analogue clock--showing 24 hours on its face. Those 24 hours stand for the past 5000 years, about 208 years an hour or about 3.5 years per minute. We shall start the clock at midnight 5000 years ago, at a time when the ancient civilization of Egypt was first appearing on the horizon of history. The time 24 hours later, the next midnight, represents the present day. We have a clock of complex civilizations since the ancient Egyptians and Chinese, but we do not have a clock for all of human society, which for Aboriginal society in Australia, for example, may easily go back another 40,000 years or about eight "days" on our clock.

FIGURE 1
5000 YEAR, 24 HOUR
     CLOCK

MIDNIGHT

10PM to 10:30PM
Rise of Modern
Science
1550 - 1650

11
10
9
8
7
6PM
1AM   Pyramids
3
4
5
6AM

British in Australia
1788

20th century

2PM
NOON

Height of
Roman Empire
- 100AD

Twenty four hours ago the great ancient civilizations were first stirring, and 24 hours later it is right now and we are right here. Try to drop your modern technological and scientific prejudices, that everything before World War II, or before last week, is the 'dark ages'. Try to realise the following about the ancient Egyptians 5000 years ago: Instead of looking at them as 'non-scientific', 'non-technological' people, perhaps therefore 'dumb', irrational and 'deprived', we should think of them as being quite clever and self-aware. Actually they were no different from us, biologically certainly no different at all. They accomplished a great many things, and they had their society pretty well organised. They could, for example, build pyramids, or better yet they could use slaves to build pyramids, based on their designs, for them. That's no mean achievement--not that I am endorsing slavery...or pyramids (although I'd like to see a modern government try to organise itself to build one). I am taking a dispassionate view--our moral disapproval is less important here than concentrating on the Egyptians' knowledge and capabilities.

Slaves built the pyramids, and the slaves were captured through victory in war, and war was waged by organising the Egyptian population to produce an agricultural surplus, turned through vast social organisation and craft skills into trained men and material for war--the army of the Egyptian state. While

all of this was occurring religious beliefs, cultural and artistic practices greased the wheels of everyday action and thought absorbing huge quantities of material, human resources and ingenuity. **Conducting their successful business in this empire building way for literally thousands of years the Egyptians were on a roll--although, and this is my point, they had no modern science (of course) and although they obviously had all types of workable material and organisational technologies, their technologies were not and could not be based upon modern science, which of course did not then exist. They simply had 'craft' technologies, as has every society in human history, including our own--until very recently**.

On my clock of civilisation, again starting 5000 years ago at midnight, perhaps you would be a bit shocked to find the Egyptians building the pyramids and otherwise carrying on as described at 1 am in the morning--that's right, the pyramids were built by these people one hour after the clock started running.

We are trying, remember, to get a sense of the oddity and novelty of our own science based society, so let's place ourselves further into this time context. Take, for example, the ancient Romans and their Empire which at its height completely dominated the entire Mediterranean basin (try that today), Western Europe including Britain, and the Middle East roughly to the borders of present Iran. The Romans built roads, organised legions, built fleets of galleys and fed the gigantic city of Rome with wheat mainly imported by sea from Egypt. They conquered the entire Mediterranean basin, and taxed the hell out of those peoples and cities to keep the whole machine running smoothly. They were well organised, successful in war, successful in peace and clearly nobody's fools.

When did all this occur? You probably think the Romans came right after the Egyptians, if you haven't studied history it may all be an ancient blur to you. But, in fact the height of the Roman Empire, from about 50 BC to 250 AD occurred between 3 or 4 pm on our clock, that is in the middle of the afternoon of the day that started with the Egyptians at 1 am. **It's getting late in the day, you'll admit, and guess what, those talented and efficient Romans did not possess any modern science either! Their craft technologies, much like the Egyptians' were not and could not have been based on science.**

Now we begin to feel the force of this analysis. Our society is based on changes in science and technology that have occurred over approximately the last 300 years, or over the last hour and a half on our clock, since 10:30 pm.

First there was the rise of modern science during the 17th and 18th century, the so called Scientific Revolution, which was then overlayed by and linked to the rising so-called Industrial Revolution during the late 18th and 19th centuries, at least in Western Europe and North America, with a rising tempo of industrial development over the last 100 years. (Neither event--Scientific Revolution and Industrial Revolution--actually deserve that title, they were slower processes, each linked to previous achievements reaching back several centuries--but that is a fine point for study elsewhere in HPS).

The Scientific Revolution, the rise of modern science, the period from Copernicus through Galileo down to Isaac Newton lasted from the mid 1500s to the late 1600s--from about 10 pm to 10:30 pm on our clock--very recently in fact and after much human history and history of civilisation, including Western civilisation had occurred. **It's as though history did not really need us or our science and technology. Civilisations had been existing for thousands of years before modern Western science was invented and before Western technology started to be linked to modern Western science. In a real sense for most of history civilisations did not need or even know modern science and science linked technology. So we are odd, not inevitable, and needing explanation and investigation.**

Continuing this time exercise--when did the British imperialists arrive to take over Australia--well a little over 200 years ago, or about at 11 pm on our clock. And all the mess of the present century, two world wars (1914-1918 and 1939-1945) as well as the rise and fall of the Soviet Empire (1917-1990) has all taken place during the last 26 minutes. I have been alive for 13 minutes and those of you who are 19 or 20 are all of 6 minutes old. **So, really, we are talking about a tiny chunk of human experience being dominated by modern science and science-linked technology--only over the last hour, and increasingly over the last 45 minutes. Starting in Western Europe and spreading to North America and thence to Japan in the last 10 minutes, modern science and technology are increasingly globalised, and transforming all present societies and economies in their wake.**

The picture becomes even odder when we recall the age of older human societies, older even than the great civilisations that seem to get the undue share of attention from historians. As I said, Aboriginal culture, which of course involves elaborate, beautiful material, spiritual arrangements, and a set of crafts and technologies, is conservatively estimated to be at least 40,000 years old--or a full eight days older than our 'day of civilisation'. **This really makes our**

Western experience with modern science and technology look recent, odd, and unexpected, and certainly falling outside the long run of play or realm of human expectation. Our little world based on science and technology is in this perspective so tiny and so odd, so contingent--it did not really have to happen at all or at least occur in that particular way!

We are an odd little blip in human history--neither God, nor destiny nor history, nor even civilisation dictated our strange trajectory to modern science and technology; but, for reasons that need to be understood, modern science and technology have developed, and developed into defining institutions in the modern world, and Western modes of life, dominated by science and technology are now bending the entire globe to their needs and imperatives. This, then, dramatises the sense in which there is something compelling, overwhelmingly important, and not in the least obvious or simple happening.

This thought experiment leads me to a key point about the subject: **To a large extent this subject is about the problem that while we are surrounded by and are constantly affected by science and technology, we do not really have much understanding of them as human institutions, as social institutions with complex histories and impacts--we don't know how things came to be this way, or even how to understand present and future trends of science and technology.**

Or to put a real point on this, it is rather as I said before, many of us think we understand science and technology. Indeed many of us have available a set of standard stories about the nature of science and technology. It is the idea that science and technology are objective, value neutral, possessed of an inner rational logic and therefore need to be isolated from social, political, economic and cultural influences or inputs. **We want to explore this common belief or story, showing that it is less a valid and helpful story, but rather more of a 'cover story', a simplistic legitimation for not asking the hard questions, a cloak that does more to hide the true human, historical and social character of science and technology than to reveal it.**

In talking this way about cover stories that are hiding the actual human and social aspects of science and technology, I am already introducing you to what social scientists and humanities scholars can begin to say about science and technology. You see, most historians, sociologists and anthropologists know that any important institution or practice within a society is usually surrounded by stories, legitimations and myths, whose functions are to explain to members

of the society what that institution or practice is: how it supposedly arose; why it is important and must be preserved and honoured, and what societal members owe that institution or practice.
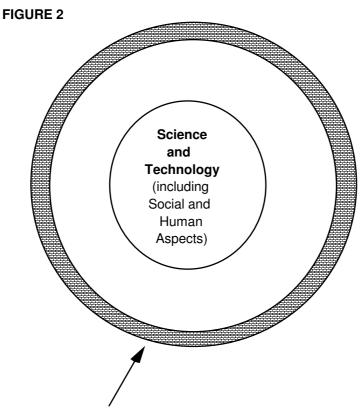
Sceptical and inquisitive visitors to a society--anthropologists visiting in cultural space, and historians visiting the past--may say, **no, there are other explanations of the origin, nature and functions of an institution than those offered through the members' myths. Social scientists may wish to explain both the actual nature of the institution in question as well as the attraction for societal members of the covering myth or story in which they fervently believe.** That is, the historian or anthropologist does not necessarily believe the natives' story about the institution, the myth that explains the institution to the native; but the historian and anthropologist do credit the native with genuine belief in the myth and they try to understand (1) how the myth functions effectively for the natives, even though (2) the myth does not adequately explain the institution for the visiting social scientist.

In the field of HPS, and in its parent fields of history and sociology of science and technology, we tend to believe that our modern science and technology are legitimated and explained to natives of Western culture according to a set of interlinked stories or myths which have grown up over the past 300 years and which many people in our society take as adequate and coherent accounts of the origin, meaning, functions and significances of modern science & technology.

That is, like the anthropologist and historian above, we think **that there is a difference between what actually happens inside modern science & technology and what the myths or legitimations tell us. That there is a difference between, on the one hand, the actual history of modern science & technology, their actual manner of development over time; and, on the other hand, the picture of the origins and dynamics of modern science and technology portrayed in the commonly accepted cultural stories about them.** We further believe that the myths or covering stories seem to most people to be conveying the truth about science & technology, whereas their actual historical, social and human complexity is rather different. **We believe, in short, that it is the job of HPS scholars, and of historians and sociologists of science and technology in particular, to explore the origins and nature of science and technology, as well as the history and nature of the legitimations and myths that represent science and technology to the general public and which thus serve to support and protect them.**

What we try to do with first year students who have never perhaps looked at science and technology in a critical way, is to awaken you to the beliefs or attitudes about how science, technology and society interact that you carry around with you. These attitudes remain unexamined because you have been socialised within the ordinary working framework of our western style culture. So this subject is oriented around a series of four beliefs that you probably hold, and which we want sequentially to examine and reconstruct in a more informed manner, using what historians, sociologists, philosophers and others have recently learned about the nature of science and technology, and their relations to society.

This subject aims to look at these four interlinked stories, piece by piece, element by element, carefully deconstructing them using historical, philosophical, sociological even anthropological insights to build up a more realistic picture of what modern science and technology are as human, historical institutions. The image is one of a covering shield, which many take to the thing being covered. We want to expose the cover as a set of stories, as powerful, attractive stories which are misleading about the real nature of what they mask. (fig 2)

FIGURE 2

Science
and
Technology
(including
Social and
Human
Aspects)

Cover stories, legitimisations,
myths - hide our view of the
human and social aspects of
science and technology.

Here, then, are the key points from these four interlinked stories about science, technology, society and progress--not the full detail of the stories themselves-- these are highlights from the stories which need fleshing out:

1. Science discovers the truth about Nature (which = scientific knowledge)

2. Technology applies scientific knowledge to practical ends

3. Society Adapts to Technological Innovations

4. Humankind [happily] benefits and social progress results

We thus start with certain beliefs about what science is; we go on through beliefs about how technology depends only upon science; and we view society as simply acquiescing to inevitable technological advances, with the automatic result being widespread benefit and progress.

We are analysing the **narratives** and tales about science and technology in order to compare them against what modern critical research reveals about the actual

workings of science and technology--critical research in areas of HPS including the history of science and technology, the sociology of science and technology and political economy of science and technology.

Let me give you a rough version of these four stories here. You know them-- they pervade the media; they are in the newspapers, they are in the prefaces to your science text books (before the real detail and hard slog of actual science in the bulk of the book.) We live and breathe these stories. It is important and fascinating that these stories circulate and are so pervasive in shaping almost everything that we think and say about science, technology and society in our modern world.

The first story begins like this:

There is a special and uniquely valid method of obtaining objective, reliable and true knowledge about nature. That way is called **Western Science**.

Western Science produces objective knowledge of nature by using a special technique or approach called, **'the Scientific Method'**.

Scientific knowledge is objective and true because it is nothing more than a skilful summary and generalisation of natural facts--**Scientific Method** is what permits scientists to produce objective knowledge based on facts unblemished by bias, ideology, subjective wishes, social interests and religious beliefs etc.

Scientific knowledge therefore is congealed fact, with nothing 'social' or 'subjective' added. Scientific method is the special technique possessed by scientists, and only by scientists, for observing facts, generalising about facts and testing those generalisations so that they become reliable objective laws and theories of science.

Scientific method is the technique that guarantees that observations are objective, that no bias, prior belief, ideology, theology and subjective wishes etc permeate scientific knowledge.

Scientific knowledge is distilled fact, a photograph or video of nature--or as medieval philosophers put it, a 'mirror of nature' in the minds of men [sic: human beings]. Through scientific method the facts of nature crystallize in scientists' minds forming organised, distilled laws and theories,

uncontaminated by any of the social, psychological or subjective material that normally clutters up human minds and perceptions.

Well, that is great--we should thank God, or fate or ourselves that we possess a method of securing such certain, reliable knowledge of the way nature really is, of the patterns and the facts of nature.

We now proceed to the second story, which introduces our Western technology--not the technologies of native peoples, like the Aborigines, or of ancient peoples like the Egyptians or Romans, but Western technology which, in the story, is simply and solely the product of applying Western scientific knowledge for practical purposes. That is what technology is, applied science, it consists only in that, and so whatever technology is innovated is simply, as it were, the neutral result of applying already verified scientific knowledge.

Continuing story #2, our technology is applied science, and our science is merely distilled fact. The technologies of other peoples and cultures fall short of this, because their technologies are **not** applied science--they have no [Western] science, and other cultural, subjective, irrational elements make their way into their technologies. The ingredients are contaminated, unlike the pure science that forms the essence of our technologies. Egyptian technology, for example, which I praised above, becomes in this story something weak, limited and aborted perhaps. Why, because the poor Egyptians had no real science to apply as technology. They worked by trial and error, by luck, and so into their technologies came the contaminants and biases of culture, religion, personal subjectivity, and irrationality.

According to our story, Western technology is applied Western science and Western science is congealed, organised and tested fact. We clearly are on a roll here, an upward trajectory of progress toward true knowledge and of the wonderful application of that knowledge in constantly improved technologies. We seem to have a way of tapping into the unvarnished truth of nature, and hence our technologies are based only upon truth--that presumably is why all our science is so powerful and works so well.

The next stage (story #3) introduces society, which you may recall had to be left out when we talked about science and technology: society must not meddle in science lest scientific knowledge be biased and not objective, and our technology tainted by cultural or social factors. The only proper, rational place for society to enter the equation is at this third story, where a grateful society

accepts technological change unquestioningly and adapts to whatever demands new technology exacts in the social and personal realms.

The argument therefore is that any 'rational' society--and clearly there are 'irrational' societies around as well--societies lacking the wit and commitment to have modern science and technology--any 'rational' society will adapt to whatever technological changes and innovations come along. To resist would be ridiculous, because technology is just applied science, and science is just organised objective fact. It would therefore be irrational to stand in the way of developments based on objective knowledge--what basis could we use to oppose new technology??--myth, religion, ideology, personal subjective taste?? No, clearly that is what less developed societies do--we have only one rational choice, to adapt to technological changes. Technological change, based on science, is inevitable, and we must adapt to it, indeed welcome it, or so story #3 goes.

Finally one may ask, 'Why welcome technological change?', and that involves the final link in the chain of stories. If our science is based on truth, and our technology is just applied science, then technological advances will be for the best, at least in the long run. By adapting society and ourselves to technological change we guarantee in the long run an increase in total societal happiness and progress.

Story #4 suggests that we **all** will benefit, **at least in the long run**, from the unconditional adaptation of whatever technological changes result from applied science. **That** is what we mean by **social progress**--the material betterment of all of us based on technology and science.

Note that this idea of human or social progress includes and amplifies notions of scientific progress and technological progress included at earlier stages in the stories: (1) Use of **Scientific method** guarantees the continued development of science--**scientific progress**, the enlargement and deepening of our true knowledge of nature; (2) continued application of science to technology guarantees the development of better and better technologies--**technological progress**; and (3) we have just seen that the bottom line of following this policy is **social betterment--social or human progress**. We shall need to follow this theme of progress as it weaves through our stories of science, technology and society. **Needless to say, just as we are going to deconstruct these stories during the course of this session, so our view of what it means to speak of**

progress in science, technology or society is going to become a lot more complicated and worth worrying about.

These stories, with their common thread revolving around the idea of progress date from at least the 17th century, the time of the so-called Scientific Revolution or Rise of Modern Science, with the work of Galileo, Bacon, Newton and others. These figures told us that their work depended upon a new method of science that they had invented and applied, and that if we fostered that method not only would the sciences grow and perfect themselves but technological spin-offs would result. In the 18th century, the optimistic rationalist philosophers of the day went a bit further, saying that science and its technological applications could lead to progress, sweeping away irrational institutions and practices, ultimately leading to a social and political utopia. At the end of the 18th century the horrors of the French Revolution and Napoleonic Wars made some think that the cult of science and reason had gone too far. This minority of critics, call them Romantics, also recoiled at the social and moral implications of rising industrialism which for optimists was further proof of the idea of progress based on science and technology. In the modern world of the last century or so only a few intellectuals and artists have tended to deny the optimism of our stories or the elements in them.

In a very real sense, these four linked stories have formed the master myth, or **master legitimatory narrative** for Western societies since the 18th century increasingly displacing religious beliefs, and theological narratives from the centre of Western consciousness. For example, these stories are so basic that they have underpinned both left and right wing ideologies, and regimes, since the 19th century. Whether you are a free market economic rationalist of the right; a 'centrist' social democrat; or a more firmly leftist socialist or communist of some description; thinkers and politicians from the left and right of the political spectrum, have overwhelmingly subscribed to these stories, giving them slightly different interpretations depending upon their immediate political beliefs and aims.

Karl Marx accepted and preached a doctrine of social progress ultimately dependent upon the power of science and technology to stimulate a break with the existing inhumane social and political relations of capitalism. Marx wanted to replace capitalism with communism, but science and technology would be the motor of change. What Marx was promising in the end was this: in capitalism since the 16th century, science and technology had developed well, but in a distorted way because of selfish, destructive and competitive capitalist

social relations. Capitalist science and technology were infinitely better than the science and technics of the feudal, medieval stage--but capitalist social relations still stank. A socialist or communist society promised even better, higher, science and technology with more wonderful developments, but now in a fairer more equitable and classless society. Again a story of progress based on an autonomous interlinked science and technology powering social change (=progress)--and that is the core part of the story concerning science, technology and society that we have been emphasising for your consideration.

This, clearly, is a version of our science, technology and society stories--told in a Marxist, revolutionary way, but again stressing the ideas of social progress resting on the necessity of accepting and advancing technological changes which themselves are the fruit of our science. Existing social, cultural, political institutions and beliefs simply hinder and distort the beneficial effects of science and technology, spinning them into the class interest of the capitalist ruling elites. However, in a communist utopia all will benefit, presumably unendingly, from the unleashing of science and technology in a 'classless society'.

Of course there have been right wing versions of the story in modern times as well, going back to the optimistic philosophers of the 18th century Enlightenment. Capitalism will be constantly improved, wealth and comfort will be more widely produced and fairly distributed by the action of a free market which includes total freedom for and obedience to scientific and technological innovation. Our right wing `economic rationalists' envision a world in which entrepreneurs and corporate innovators make unfettered use of every development in science and technology free from government, union, or other 'special interest' influences. This supposedly will develop the economy, a process which in the long run produces wealth and comfort for all, a consumer techno-paradise, such as that mythologised through the images of our present advertising culture.

Conservative economists suggest that economic 'science' gives them hard conclusions that dictate their policies and political programs. They argue that although quite a few people may suffer in the 'short term' the only way toward social progress is to free up markets, business and technology innovators so that they can ride a wave of progress and wealth creation that will ultimately benefit all--sound familiar? So everyone from Marx to Mr. John Howard , from the far left in the 19th century to the far right in the 20th century pinned their particular political pitch on a basic, agreed story of the progressive interlinkage

of "science leads to technology" -- "leads to adaptation" -- "leads to general benefit and social progress".

Over the past 150 years, pundits of both the left and right have drawn upon the same basic narrative model, the same mythic material to spin their tales of how science, technology and society will interact to produce progress. Like those optimistic 18th century philosophers of the Enlightenment, pundits of the left and right have held out the prospect of progress toward a secular (non-religious), material utopia on earth--through the progress of science and technology.

If it sounds like a transposition of the old Judeo-Christian promise of a heavenly utopia for those who have made moral or spiritual progress, that is not far wrong. Our western progress, or salvation story about science, technology and society is based on that older religious template. The idea of progress relating to science and technology is a secular, earthly version of the older narratives of spiritual and heavenly salvation. Salvation is now for all and on Earth and in historical time, brought about by being rational and following scientific method and accepting technological changes that result from applying scientific knowledge. As a corollary, we are lost, we lose out and fall short of our destiny if scientific method is not followed, if technological innovations are not fully embraced. It is bad to obstruct or not follow the findings of scientific method and its technological applications; it is good to foster science and technology and follow precisely where they lead us. That indeed is a secular theology, a secular version of the Christian salvation story. [2]

The question of course, is does the science technology and society story really tell us how science works, what technology is, how it relates to science and how both relate to society? Or does this story exist to legitimate present scientific, technological and social arrangements. To make us not think about or analyse these things, and just accept whatever turns up as 'necessary', as well as 'rational', 'good' and 'progressive'?

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[2]It is also a lot like the great alternative secular philosophy of the 19th and 20th centuries--Marxism. Marx rejected religion as an illusion and mass propaganda manipulated by the ruling class, but he believed that in the long run an earthly salvation would be achieved under communism and that communism would triumph at the end an historical process of change and revolution--as capitalism had replaced medieval feudalism, so communism would replace capitalism--due to upheaval fuelled by misfits between existing class structures and the development of science and technology (the forces of production). Let science and technology rip, develop fully, and they will contribute to a situation in which existing capitalistic social relations will be burst and a more equitable, more fair communistic society will come into existence, in which science and technology will really serve and liberate all.

Many of us will not believe so baldly and simply in this commonly understood story of science, technology and society. But all of us, and I include myself here, have been brought up with these stories, they are woven into our everyday understandings and representations and beliefs about the world and we more or less accept them, piecemeal, and rather uncritically as we go about both our private and professional lives.

Since the 18th century it has been very unusual in Western history for people to question the story. In the 19th century a few romantic literary and artistic figures did, as well as a few other idiosyncratic intellectuals and religious types. **But, in the past century there has been an erosion of the stories, and a questioning of the meaning of progress.** This started perhaps with the Second World War, with its legacy of technological genocide and nuclear weapons, and accelerated since the 1960s on a number of fronts involving questioning the meaning, costs, and ethics of progress in areas, for example, of health, the environment, technological change and unemployment. Since the 60s various activist groups and cultural movements: feminism, environmentalism, cultural radicals of different sorts, have variously espoused and articulated aspects of these concerns against the backdrop of continued main-stream support for the traditional stories in the mass media, and in the political and economic elites.

Over the same period, from the 60s onward, the field of HPS and more particularly its more important component disciplines, such as history of science, history and sociology of technology and political economy of technology have also been developing serious scholarly critiques and understandings of how science, technology and society relate.

Growing up primarily in British, French, North American, and yes, Australian Universities, these fields have worked toward more realistic pictures of the history and nature of science and technology and of how they interact with the societies, economies and states in which they are embedded. We are here to be introduced to the recent findings and method of these fields.

However, and this is important to remember, we are not here to debunk or rubbish science and technology, or scientists or technologists. We are here to try to understand what science and technology are as human, historical undertakings, once the simplistic cover stories about their natures have been dismantled. That is, we are here to debunk the old cover stories--to see that they hide, cleverly hide, the social and historical reality of science and technology. We want to lift the cover, get beneath the glib simple story, and

use serious academic skills--the skills of historians, sociologists, anthropologists, psychologists, economists, political analysts etc--to investigate the actual nature and history of science and technology in their social relations and consequences.

It is of great importance to be clear about the relations between HPS, an academic discipline, and those wider trends of criticism of science, medicine, technology and the environment now growing so strongly in our society. Many people who are committed to agendas critical of technology, or some aspect of medicine, or some aspect of environmental practice or policy will tend to fall into an intellectual 'trap' here which a person well educated in HPS research should not fall into. This trap consists in mistaking the cover stories that protect science and technology for science and technology themselves. To attack the traditional cover stories is not to attack, much less to understand science and technology in their social and human reality--for it shows a lack of understanding that science and technology come packaged for everyday understanding in their covering narratives and myths.

For example, some environmentalist criticism of present industrial or government practices appears as though it is rejecting or debunking existing science and technology as such. Similarly some feminist criticism of present health and medical policies sounds as though it is writing off modern medicine as a conspiracy between male doctors and drug companies. [Note I say some not all--this is just for the purposes of making a point].

The problem here is that this kind of blanket criticism tends to be taking the traditional cover stories at face value--doing just what we want to learn to avoid--that is mistaking the contents of the cover stories for the contents of actual science and technology and then going to town in criticising their nasty aspects.

Now we scholars in HPS and its component fields would say, or should say, that the first intellectual and political task in the early 21st century is to penetrate those cover stories, to learn what science and technology are, have been and how they actually interrelate to society. If we stop at the level of the stories we become merely consumers of these stories even if our outlook is now critical and pessimistic as opposed to the usual optimistic attitude Western intellectuals have displayed toward them. **Our job in HPS is to deconstruct the cover stories and to open up science and technology to serious scholarly analysis--historical, political, sociological and philosophical etc. Our job in**

HPS isn't to parrot simplistic activist criticisms of Science and Technology which are really nothing more than negative versions of the cover stories.

There is a distinction between the critical research and analysis of Science and Technology done in HPS on the one hand, and bald, intellectually uninformed activism and debunking on the other. But there can and should be a link! We'd prefer to see political activists who are critical of existing science, technology and medicine informed by what our discipline is revealing about the history, nature and social relations of science and technology.

So much for the key pitfall that political activists are likely to face in trying to grapple with science and technology without a background in HPS analysis. There are two other common pitfalls encountered by a lot of people, not just political activists, who try to understand or criticise science and technology from a social, political or ethical perspective: These pitfalls can be termed (1) the Use/Abuse model of science and technology and (2) the 'Black Box' model of science and technology. A key aim of HPSC 1400 is to reveal the limitations of these models and to supply you with intellectual tools that reach well beyond them for the understanding of science and technology in their social and historical contexts.

(1) The Use/Abuse Model

A lot of criticism of science and technology, especially on environmental or health and medicine issues, or on issues concerned with war and technology or nuclear energy and weapons tends to take the form of what has traditionally been called the 'Use/Abuse' model. This says that science and technology are actually value-free, objective, neutral in themselves and that it is good or bad people or institutions that determine whether a bit of science or technology is to be praised or condemned. That is, people make science and technology good or bad; in themselves science and technology are neutral and objective. You can see that this idea depends upon our standard cover story according to which, yes, science is objective, just congealed fact, and technology also is neutral, being simply the application of a value-neutral science.

Now in simplistic cases this model may work. Consider a simple technology, a knife. It is so simple because it is an isolated artefact, not part of some larger socio-economic-technological system in which it is made and used. Clearly a knife can be used for good or evil. In some real sense knives are neutral and are either used or abused by nice or nasty people.

Let us now consider a more pertinent and interesting case. Not a one-off tool or artefact, but a technology like nuclear energy generation which is actually a gigantic system of supply, production and distribution, consisting of many subsidiary human, scientific and technical sub systems. You must have all those sub-systems operating in order to have the technology of nuclear power generation. The entire system also fits within the economy, political system, human and natural ecology of the society in question.

Well here, of course, we could speak of outright abuse, say deliberate environmental vandalism, or the failure to carry out safety or environmental standards on the part of deliberately 'bad' people. **But the real issue would be the social, political, ethical values and aims built into that system regardless of whether nice or nasty people are running it.** Some of these values would be, for example, tight security extending widely across the society; perhaps extensive surveillance and narrowing of civil rights. Certainly the centralisation of energy use and distribution decisions, and the pattern of transport and infrastructure systems to service the needs and dangers of the system, fall into this category.
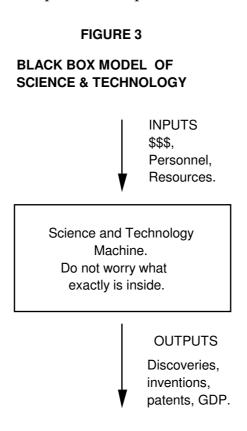
In this instance the system or technology for generating nuclear power would not be neutral. It would demand and entail certain kinds of social, political, legal, even psychological arrangements in the society. Such large technological systems are never neutral--they always carry with them leanings toward whole sets of particular social-political and economic arrangements. The system is not neutral to the people or society in which it rests, it partly shapes and conditions that society and those individuals in order for it to continue to function.

Now, a lot of activist criticism of technological, medical and environmental issues is naively individualistic, it assumes neutral science and technology in nasty people's hands being abused. **What such criticism lacks is an understanding of how history, society, government and economy shape the science and technology that we get (and that we do not get). How these technological systems, once established in turn shape the society, economy and politics surrounding them and thereby 'make history' as well. This happens beyond the good or evil intentions of particular individuals or groups, and is not about neutral systems being abused, but about systems which already embody, express or demand particular values, aims and practices in preference to others.**

In section 2 of this course we are going to devote a lot of attention to the idea that technological systems are socially and historically shaped, and that they in turn have massive social consequences.

2. The Black-Box Model of Science & Technology

The Use/Abuse model is also closely related to our second common pitfall, the concept of the 'black box' model of science and technology. This model borrows from engineering the idea of a black box, which is a part of a system or design that carries out a specific function. For purposes of design and analysis we do not worry about what is inside the 'black box', or how it carries out its work. All we worry about are the inputs and outputs--put in money or energy or resources and out comes work, or products, or effects of some sort. (fig 3). It is assumed that some expert somewhere actually knows how the black box works and what is inside, but for purposes of planning, design and analysis, the inside is unimportant--only the inputs and outputs need to be measured and assessed.

FIGURE 3

**BLACK BOX MODEL OF
SCIENCE & TECHNOLOGY**

INPUTS
$$$,
Personnel,
Resources.

Science and Technology
Machine.
Do not worry what
exactly is inside.

OUTPUTS

Discoveries,
inventions,
patents, GDP.

According to this model, which many economists, politicians, policy-makers and scientists themselves believe, science and technology are socially, politically and ethically neutral, they are merely bodies of objective knowledge and technique. [This should sound familiar!] So, of course, science and technology are not open to investigation by the humanities and social sciences--by history,

philosophy, sociology, politics etc, because there is nothing human, social, historical, subjective in there. Unless some 'baddies' have 'abused' the credo of the scientific method and not been 'objective'. [This should also sound familiar by now!] Therefore, according to this model all the social sciences and humanities disciplines can do is study the inputs into the black box of science and technology--inputs like money, trained man-power, infrastructure, and then measure the outputs, things like numbers of patents, numbers of inventions, economic performance etc. This is how a lot of science and technology policy planning is conducted in the modern world.

Clearly such technical black boxes are in themselves neutral and have nothing to do internally with anything social or political or philosophical or historical. This again is what we deny in HPS and in its component fields, such as history, philosophy and sociology of science, or history and politics of technology. We insist that science and technology have complex human histories, and complex internal social, political and economic anatomies--and that they can be studied by scholars in the social sciences and humanities, and that, finally, the only reason that science and technology look like black boxes is that the cover stories are there to hide them and make them look that way. The cover stories provide a shield, an explanation, a legitimation of science and technology and divert us from looking hard at the social and human character of science and technology. That, in the end is what we in HPS are really concerned with.
(consider fig 2 again)

What we are presenting you with is a scholarly analysis of science, its history, nature and social relations. We are not attempting to rubbish science, or to sell our own particular views about medicine and health, the environment, unemployment etc. I have my own views on those matters: some might seem quite radical to you, some may even seem quite conservative to some of my activist friends. It does not really matter here, because I am not interested in influencing you one way or the other on particular contemporary science, technology, medicine and environment issues--you can make up your own minds. I am, however, interested in giving you some tools, findings and perspectives from my own field, and indeed in part from my own researches in my own field, to help you understand what science and technology might be as real world, human activities, with real social, political and economic relations and consequences. Part of the job is to show you that our task is made difficult by the cover stories, which we must deconstruct, and understand as legitimating myths hiding the real action of science, technology and society.