Rethinking Economics and Education; Exponential Growth and Post-Growth Strategies


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Abstract: Education is increasingly vocational, at the service of the continuous exponential increase in economic growth, while climate change is an outcome of these same economic values and praxes. All attempts to come up with technological or values shifts keep getting absorbed and overcome by the pressing motif of economic growth. This chapter uses Heidegger’s concept of the technological enframing of modernity, to view Keynes’ notion of economic growth, which he called the ‘multiplier’, and the pace of consumerism that has taken over every aspect of knowing about the world we live in. The article asks us to think through our technological enframing anew by looking to an early mechanical Greek artefact, the Antikythera Mechanism. It portrays a cyclical notion of time, defining the rhythm of economic growth and degrowth in the State. This earth centric cosmos helped Occidental economies stay within the parameters of the local ecology, with economic growth that is not exponential but cyclical, teaching us about steady state civilisations that survive for millennia. An earth centric cosmology creates a different set of values, where the pace of consumerism needs to be governed, rather than being allowed free reign ‘as by an Invisible Hand’. The role of education is twofold in this exploration; it’s a pivotal site for cultural exploration and transformation, and secondly, it’s contained by the expectations of the State so while economic growth dictates those expectations, education is subservient to these values. If we aim to overcome climate change we need to transform the expectations from outside and within.

Economics and education

Neoliberal market economics has dominated the education sector to such a huge extent over the last 20 plus years, that it is hard to imagine that education has not always directly deferred to the economic imperative. The sector is seen through a market lens; schools compete with each other for ‘consumers’, teaching and learning is a ‘product’, schools serve to increase the human capital of students by ‘adding value’ through a series of accreditations, assessment is a means for the job market to judge the quality of educational ‘outcomes’, and thus the Human Capital of the student, and so forth.1 Every layer of education can be understood through the neoliberal market metaphor. Partly this is a result of the market being seen as a universal, larger than any sector, larger than the planet; guided as though by (God’s) Invisible Hand.2

The economic imperative is both systematic and yet flexible enough to include innovation and profit. It includes a nod to equity and diversity. Apparently it trickles down wealth and

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thus caters to the needs of both the rich and the poor. The environment tends not to fare so well, and until recently was completely ignored as an ‘externality’ to the economic model. But lately ‘sustainability’ has included even environmental concerns, and the system has demonstrated that it is capable of expanding and adapting to new needs. Similarly, economic growth was not part of the original model, but since Keynes theorised it in his book *On the Means to Prosperity* with his concept of ‘multipliers’ in the 1930s. In the 1950s growth became legislated and is now a core assumption across the globe.

**Universal education, universal market**

The universalisation of education is not simply based on the universal structure of the neoliberal market. It goes to the earliest extent of the shift from feudalism to modernity. Universal provision of education became a key tenet of liberalism at its outset, justifying the challenge to feudal monarchy by providing a pathway for brilliance and leadership to emerge from all levels of the community, and not just its elite. Liberalism replaced leadership by Divine law, with Universal law.

Thus far, the education sector remains riveted in the Universal configuration that initiated the widespread emergence of schooling. Later in the 1990s, it enabled the neoliberal market to overlay existing universal discourses of education in a relatively straight forward immersion of one structure into another.

For many policy makers, thinking outside of the easy formula of neoliberal rationality and self-interest is next to impossible. The assumptions of neoliberalism and the market rationale are so embedded that they are nigh invisible. ‘There is no alternative’. Education is often led by Minister’s with no background in the sector, but who assume that the market model will prevail here as it does in other parts of the government.

**Technological determinism**

Heidegger saw this shift emerge. He wrote about it in terms of a major shift in the essence of technology, from craftwork to mass production and consumerism. After the second world war, in 1956, Heidegger wrote an important text called “The Question concerning Technology”. In this text, he argues that modernity is shaped by technological enframing, or the *Gestell*, that has changed the way we understand the world, and the way we understand ourselves.

Heidegger argued that technology had profoundly altered from its earlier beginnings in Ancient Greek culture. The essence of modern technology ‘frees’ us from the erratic climatic

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conditions of the local ecology, and at the same moment, ‘alienates’ us from belonging to our local place.

According to Aristotle, there are several core elements to the telos of technology. The type of materials dictates the type of thing, its shape and capacity. The craftworker’s skill in design and fashioning dictates how proficient and elegant the thing will take form. The *causa sui* or ‘final cause’ is the intention or aim of the item. The telos derives from the *causa sui*, the skill of the craftsman, and the materials which all combine to ‘cause’ the item to take shape.

Heidegger argues that the modern turn signals a significant further element to the essence of technology. It is partly a question of scale. Instead of one master craftsman, industrial mass production has altered the telos of the technological. But it is not simply the multiplication of items, but rather the shift from embedded practices to alienated ones that most clearly signifies the modern turn. For Heidegger, modern storage is the key to understanding the full shift in the essence of technology.

He argued that storage changed the relationship of people to materials, to place, and to things themselves. During the craftwork era, the tempo of the seasons and availability of materials dictated the creating of things. Heidegger argues that storage capacity changes the tempo from the seasonal carrying capacity to the rate of consumerism. In a pastoral world, the mill would grind seed according to the seasonal ripening of the plants, and the seasonal flow of river water in the waterwheel. But once storage is introduced then the river gets dammed and the seed imported when out of season, so the production of flour occurs at the rate of demand rather than the rate of seasonal flow.

That expediting is always itself directed from the beginning toward furthering something else, i.e., toward driving on to the maximum yield at the minimum expense. The coal that has been hauled out in some mining district has not been supplied in order that it may simply be present somewhere or other. It is stockpiled; that is, it is on call, ready to deliver the sun’s warmth that is stored in it. The sun’s warmth is challenged forth for heat, which in turn is ordered to deliver steam whose pressure turns the wheels that keep a factory running.⁶

All early communities were constrained by the seasons, but modern society is governed not by the tempo of seasonal fluctuation but more by the tempo of consumerism. Anything that is not in production is waiting, in ‘standing reserve’ for the demand of consumerism to ‘challenge it forth’. This key shift in the conception of time has a profound impact on culture, and the ethos of consumerism.

As transport has become more reliable and efficient, massive storage sheds are no longer as necessary. The tempo of production can rely on global transportation systems and resources can remain in standing reserve *in situ*, rather than in warehouses. The tempo of production is

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global consumerism. Any particular local calamity can be largely mitigated by the networked market society, making the determinism of modern technology overwhelmingly complete.

Heidegger was extremely pessimistic about the determinism of the technological *Gestell*. He regarded it as so all consuming, that people can no longer see the world in any other way. We cannot look at a river in flood simply as a fierce flooded turbulence, but instead see potential energy for the hydrodam, or a resource of drinking water, or fishing, or tourist ‘beauty’ spot. The river can no longer show itself in its own way or at its own pace. It is always-already co-opted into the standing reserve of the totalising system of consumerism.

Many people are absorbed in the new mode of technology without question. The benefits of trade, especially under the further guise of economic growth, are very compelling. When local disaster strikes, people can trade their way out of the problem. Where global markets exist, famine is largely a thing of the past.\(^7\)

This freedom has obvious benefits, but it is less easy to see the disadvantages of modern technological enframing. People are less tied to their local landscape. They are less aware of local conditions or changes that are occurring. Its hard to notice water pollution or soil runoff when you rarely visit the local stream. Its easy to miss species extinctions when your whole world is inside buildings or vehicles and you rarely visit the local countryside. Its hard to get angry about developers cutting down local trees when you are completely busy with work and the day to day management of affairs. Hard to see the impact of greenhouse gas emissions when you live inland in a cool climate and the extreme cyclones, coral bleaching, and warming ocean is impacting islands and atolls thousands of miles away. Environmental issues go unnoticed. As a generalisation, for society as a whole, climate change crept up on us unawares.

Heidegger’s major point is that in the epoch of modernity, everything, including ourselves, are understood as potential commodity in the ordering of consumerism. We are ‘human capital’ put to work in the market of labour resource. The river, the field, the forest are all stores of water, of crops, of stocks of animals, of wood, waiting to be called into the market place. Nothing exists merely for its own sake. It is all absorbed in the overarching enframing of the market discourse of potential resource for consumerism. The shift from the craft work described by Aristotle to the modern technology examined by Heidegger is a shift from cyclic seasonal time to exponential consumer time.

Heidegger thought through the characteristics of modernity in terms of technology but nowadays we are more familiar with framing it within economics. Modern capitalism tends towards monopoly, polarising the rich and the poor. Worse still, the contemporary version of capitalism, combined with modern technology, has created a world dependent on cheap oil, mass transport and mass production, and with these benefits, massive greenhouse gas emissions. The impact on climate change is, as the Intergovernmental Panel on Climate Change suggests, a 99% correlation between modern technological practices and global warming.\(^8\)

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7 The problem of first world inequitable distribution and homelessness is a more recent phenomena, and could be argued to be the application of ‘standing reserve’ to humanity *in extremis*.
8 IPCC Intergovernmental Panel on Climate Change, APR4, (2013)
Keynes multiplier effect

There are deep problems with the prevailing economic model. Capitalism tends to polarise the very wealthy from the rest of the population. There are various ploys to attempt to stop this tendency in the system, such as anti-monopoly laws, and tiered taxation but nevertheless, as we are seeing all around us, the rich keep getting richer and the poor, worse off.

The education system is set up to try and offset this tendency. Universal education provides the basics of reading, writing and arithmetic to all students to ‘even out the playing field’ and through meritocracy, enable all children to potentially become one of the capitalist success stories.

Nonetheless, the tendency to monopoly, and profit to siphon upwards to fewer people, is a deeply destabilizing problem for the system. Marx recognised that the working classes had been alienated from their land and livelihoods with the land clearances, and then, when they only had access to their own bodies’ labour power, had the product of their labour underpaid, creating a very volatile situation.\(^9\) Marx argued eventually it would result in revolution and a return to the landed villages of earlier times.\(^10\)

This instability was taken seriously by a later economist, John Maynard Keynes. Keynes is most famous for his almost New Deal approach to the Welfare State. Keynes tried to compensate for the instability of capitalist profit tending to polarise society with two key ideas; State provision of a ‘safety net’ of health, education and welfare, and very crucially, economic growth. Just after the first global financial collapse of 1929, Keynes wrote a text, *The Means to Prosperity*, arguing that with continuous economic growth, working class people can expect to gradually receive the benefits of consumerism, just as the very wealthy do.\(^11\)

The political spectrum often takes sides over the provision or otherwise of the Welfare State, but both left and right have accepted completely the ‘need’ for economic growth. They have welded it into the economic model, where ‘innovation’ serves to drive profit, (and growth). Economic growth has become so normalised that it is now a sacred cow, that no one dare critique. Its benefits, as Heidegger described in relation to technology above, are clear. The working classes can save up and buy consumer goods. Nowadays countries have a minimum economic growth of gross domestic product enshrined in legislation. In all ‘developed’ countries nearly all families have television sets, sound systems, vacuum cleaners, ovens, flush toilets and mobile phones.

Already in the 1930s pollution, deforestation, and a massive reduction in biodiversity was a problem. None of these issues were on Keynes mind though, and subsequent governments all over the world have failed to see how economic growth and access to consumerism has vast environmental resource and pollution consequences. At present, consumption amounts to about 70 billion tonnes of raw materials per year globally (and it is exponential, going up in a

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\(^9\) Marx, Karl, “Estranged Labour” in the *Philosophical Manuscripts* (1877)


steep umbrella curve). Consumerism grew between 1980 and 2010 by 94% and is accelerating.\textsuperscript{12} If we continue at the same exponential curve, production will be over 100 billion tonnes a year by 2030.

We are now so committed to economic growth and the ‘right’ to consumer stuff that it is highly disapproved of to advocate a simpler lifestyle. In many cases, especially in ‘developing’ countries, people can’t fathom why there would be any problem with consumerism. Subsistence living is regarded as poverty and deprivation. Consumerism is seen as a right and any obstacles to its entitlement are problems not solutions. Consumerism, according to Marx, is necessary because of our alienation from nature, and from the gardens and natural resources that were required for subsistence living.

The deepset problem of alienation, mentioned at length by Marx in his \textit{Philosophical Manuscript}, and by Heidegger in \textit{A Question Concerning Technology} does not get discussed at all in economic circles. The link between alienation from nature (or the means of production) and the subsequent necessity of market trade and consumerism is lost to the discussion of economics, technology, progress, or growth.

\textbf{Two beginnings, climate change and Early Greek thinking}

Alienation, or freedom from the constraints of local production is central to the shift from craftwork to modern technology. Alienation is at the core of mass production and the urbanisation and ‘development’ of people from villages to cities. Both Marx and Heidegger, and even Keynes, take a very determinist view of these changes. They are inevitable, systems driven, and largely outside the control of any given individual. We are all caught up in these bigger processes, and even when we are striving, as students do, to achieve within an educational setting, the ultimate paradigm is set by the system rather than an individuals’ aims and aspirations. Indeed, the aims and aspirations are, Heidegger argues, mostly set in place by the technological enframing itself, which people rarely question, as they go about their daily lives. Consumerism governs our interactions, and it dictates our understanding of the world we live in, including the value we place on ourselves. Heidegger is extremely pessimistic about how to escape from the totalising discourse and performativity of the technological \textit{Gestell} and Marx left it to a vaguely articulated romantic call for a ‘return’ to the pastoral. Keynes is so embedded in the \textit{Gestell} he fails to see consumerism or economic growth as problematic in the slightest.

The pace of consumerism now dictates the pace of production, with little connection to the pace of which crops grow, or seasons change. All elements of nature have now been transformed into ‘standing reserve’ or ‘resource’ which is waiting to be demanded by consumer need. Nothing merely exists on its own terms. Thus, everything is ‘set-aside’ from itself and cannot ‘come forth’ (as Heidegger puts it) at its own pace. Alienation is built into the fabric

of the culture. The dictates of economic growth exacerbates this tendency of the technologi-
cal *Gestell*, making it increase exponentially year on year. The planetary boundaries are now 
seriously in question, both in terms of ‘raw resource’ and also in terms of greenhouse gas 
emissions (which is nearly at 410 ppmv, significantly higher than the pre-industrial norm of 
280 ppmv).\(^\text{13}\)

The mode in which consumerism orders the world is not within the control of humanity. It 
has been set up through the ideas of people such as Adam Smith and John Maynard Keynes, 
but it is not up to people like ourselves, or even those in leadership positions, to suddenly an-
nounce a new kind of ordering, or a new way of comprehending the world we live in.

Since man (sic) drives technology forward, he takes part in ordering as a way of re-
vealing. But the unconcealment itself, within which ordering unfolds, is never a hu-
man handiwork, any more than is the realm through which man is already passing 
every time he as a subject relates to an object.\(^\text{14}\)

For Heidegger, most of us, most of the time, are fully absorbed in an unquestioning way into 
the totalising enframing of modern technology. But he regards *questioning* as the only mode 
in which humanity can have even a glimmer of reconstituting the world from the narrow de-
finitions and pollutant side effects of late capitalism. This critical acumen is a vital part of the 
educational project. It is perhaps all we can claim, in the role of being more than cultural re-
production, and instead, at least setting the ground of possibility for new ways of becoming. 
Critical questioning is a vital component of education.

In a later and less well known text, Heidegger wrote on what he called the ‘two beginnings’.
To understand what occurs today, we need to think about our whole lifespan, from birth to 
death. Both these finite poles refract back and offer ‘beginnings’ to understanding what is 
taking place in the now. Heidegger works up this argument in terms of an individual life, but 
following Nietzsche, he radically expands it to contemplate the lifespan of a whole historical 
epoch.\(^\text{15}\) The formative features of historical events and attitudes impact on the norms and 
processes of the present. In similar fashion, the prospect of how things will end also impacts 
on how we live in the present. For example, climate change illustrates that the way we are re-
leasing vast quantities of CO\(_2\) into the atmosphere right now will melt the polar ice caps and 
land based glaciers, and raise the level of the ocean, possibly halt the Gulf stream and ther-
moshalene conductor, and kill the coral that produces most of the oxygen in the atmosphere. 
Thus, understanding the looming death of an epoch also helps us to make decisions about 
how to live more ethically in the present. The ‘two beginnings’ present an educational mo-
ment, where the systemic norms can be opened up for crucial questioning, and contextualised 
in new ways. The caveat being, as Heidegger quoted above, that questioning is not a change

\(^{13}\) IPCC, APR4, (2013)

\(^{14}\) Heidegger, “Question Concerning Technology”, p. 18.


Ruth Irwin. “Reflections on Modern Climate Change and Finitude” in *Climate Change and Philosophy; Transformational Possibilities*, (London: Sense, 2010a, pp. 48-72).
in way things show up as beings, questioning may illuminate our world more deeply but it does not yet impact on changing the normative worlding that predominates in global development. Nevertheless, with all caveats in place, Heidegger argued that both the ending and the beginning of an epoch sheds valuable light on things that simply get taken for granted ‘in the middle’ so to speak. In this article, I want to take the insights offered by climate change as given, and turn to the ‘first’ beginning of modernity, in the tempo and technology of Early Greek Thinking, and then earlier still, to the emergence of economics, accounting, writing and astronomy in Ancient Mesopotamia. The first beginning is the earliest example of ‘modern’ mechanical technology. It helps to examine just how much technology really shapes and determines the enframing of our cultural system, and how porous and open to transformation the system might really be.

## Antikythera mechanism

In 1901, pearl divers who were sheltering from a severe storm, came upon one of the largest and richest shipwrecks ever discovered in the Mediterranean. After the wind direction forced them to take cover in an unusual bay, they sent over a pearl diver off the coast of a tiny atoll called Antikythera, who came back with the arm of a statue, coins, and a piece of fossilised wood and brass with what looked like clockwork remains in it. The lump of fossilised wood and brass had a large cog with vee shaped edges on one side, and a ‘face’ with two dials and a small ball on the other side.

The artefact was not given huge attention until half a century later when an Englishman called Price wrote an article about the first analog computer, the earliest ‘clock’, invented 1400 years before clocks emerged in Europe (1959). Price stimulated a deep fascination with the earliest machine, the prototype of modern technology. The Antikythera mechanism, perhaps more than any other machine, defines the boundary between archaic cultures and signals the emergence of the modern technological trope.

Not only is the Antikythera mechanism the first clockwork, it demonstrates that the idea of ‘progress’ is a fallacy in multiple ways, for despite the development of ever more sophisticated machinery in modern times, this initial clock, the beginning of modern machinery, is then lost to human knowledge for not merely decades, but nearly one and a half thousand years.

The Antikythera mechanism was invented by the Ancient Greeks, at a time that Heidegger, and most Western philosophers, refer to as the source of modern philosophy, modern political theory, and modern normative ethics. Using sophisticated astronomical research, the star positions on the mechanism have been dated to about 206 BC. It was made about 120 years

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after Aristotle wrote his piece on the telos of craftwork. The device is essentially a calendar, not a timepiece for the hours and minutes of each day, but rather a timepiece of the orbits of the solar system; of the moon and sun (it is earth centric), and the five known planets.

The concept of telos in Aristotle pares away its association with utopian progress, innovative growth, and teleological, evolutionary improvement. For Aristotle, the telos, or the ‘causes’ of a piece of craftwork, is the potential within the materials something is made with, and the skill and intentionality of the craftsman. The Antikythera mechanism demonstrates these elements; it is made of brass in a wooden box, and each dial is hand cut with a specific number of teeth, carefully set up to mechanically replicate the orbits of each planet and the sun and moon in relation to each other and to the earth. The maker was a mathematical genius who used prime numbers and multiplier cogs, along with a pin and slot system, to create elliptical orbits, not circular ones. The Antikythera was probably not the only one made, but the result of a workshop. Brass and metallurgy made it possible to make such a detailed and intricate machine. The mathematicisation of its workings regulated the knowledge of the solar system from empirical observation to mathematical prediction (more on that later).

The clocks that were invented in the Middle Ages were mostly designed to show the minutes and hours of the day. Clocks were put up on steeples and towers, so that the population of a town could arrange to meet by them, or to work from one set time to another. Clocks quickly became instrumental in the regulation of prayer and work, *ora et labora*.

The Antikythera mechanism throws open the assumptions of progress, and the necessary telos of unidirectional ‘growth’. At the crucible of modern technology, the technē of consumerism turns out to be of quite another order. It is likely, according Freeth, that this device was not the first prototype, but the product of a group of craftspeople in a workshop, either from Rhodes, or possibly that of Archimedes in Syracuse. This was a period when Ancient Greek mathematics was very creative and changing. Maths had been dominated for centuries by geometry but in this era, trigonometry, derivatives and proto-type arithmetic equations were invented. People began to speculate that the sun rather than the earth was the centre of the solar system. Geometric and earth centred, not based on the latest mathematical derivatives or a solar centric solar system, the Antikythera Mechanism does not utilise the mathematical brilliance and the height of innovation and knowledge of its day. Instead, and for reasons to do with the *Gestell* of Antiquity, the Antikythera Mechanism owes its mathematical sources to

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long standing astronomy and geometry that were ancient even then, and emerge from Meso-
opotamia.

The Antikythera mechanism is concerned with the regulation of long term cycles; not to en-
courage the daily efficiency of performance management, but - I will argue later, as an irregular-
ity mechanism, so that the Kings and Caesar’s of Antiquity could predict eclipses, or when the planets all line up in the night sky, and they could time public events by the large cycles of the known universe. In this way, the cosmology or order of the world was defined not by human progress or the pace of consumerism but by the earth centric, solar system it-
self. Alienation was unknown, and world order was intimately tied together with the earth and our solar system.

To briefly recap my earlier argument and show how profoundly different the pace of alien-
ated consumerism is from this earlier understanding of the world, Marx had the important in-
sight that capitalism is built upon the alienation of people from their land, from their embed-
ded, subsistence culture in a particular locale. Instead, as we can see with the original land clearances, and subsequent forces of urbanisation, people were uprooted from their traditional community lands, or even if they are to stay there, they have less and less to do with their local ecosystem. Slow changes that indicate environmental stress are often missed, as people are no longer sensitive to their local landscape. Instead, as Heidegger argues, modern technol-
ogy is premised on storage and transport capacity, that increases market availability of all sorts of products from all over the world. People are no longer tied to the productivity of the local seasonal conditions, but ‘freed’ to buy and sell on the global marketplace.

Keynes argued in the 1930s that the instability of capitalism needed to be addressed so that working class people also benefit from the technological innovations, and consumer items that were privileging the upper class. Keynes is most well known for the Keynesian Settle-
ment which includes universal provision of health care, education, and welfare to all mem-
ers of the State, regardless of privilege. What is less well known, is that Keynes also intro-
duced what he called at the time, the ‘multiplier effect’. This was the commitment by nation states to increase their GDP by at least 2-3% so that gradually the economy will ‘grow’ and thus, the poor can expect to be able to save, and eventually purchase consumer goods that un-
til then had been the preserve of the wealthy. The multiplier effect, now known as economic growth, was almost universally implemented around the world post World War Two. (Bhutan is a notable exception).

The Keynesian Settlement was promoted on egalitarian grounds and set up to be universal. Education can be seen as a crucial element of the Keynesian Settlement. Universal provision of education enables talented children to emerge and rise to the top through summative as-
sessment. It is then easier for children who have excellent results to get opportunities though business or politics to become future leaders. The rest of the population are also upskilled into the necessary discipline and core knowledge (STEM for example) so they are well pre-
pared for the types of work that prevail in a capitalist economy.

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Subtle modifications enabled Keynes’ to apply his multiplier argument to the economic model itself. The economic market is assumed to tend towards a stable ‘balance’ between costs and price, “as though by an Invisible Hand”. Market failure is a result of companies failing to innovate enough to keep ahead of the minimal profit involved in market balance. The expectation is the successful companies will come up with new and innovative ways to ‘grow’ by, for example, introducing new efficiencies into their production processes, or coming up with new styles, or new products. Thus, the simple internationalisation of expertise and resources through comparative advantage into a global marketplace introduced by Ricardo is modified to include technological innovation and equate that with growth.

The unanticipated problem was that growth is exponential, and the increase in consumerism has a commensurate increase in resource depletion and pollution, including greenhouse gas emissions. Industrial globalisation is a relatively young civilization. It is only 250 years old at the most. And yet in this relatively brief space of time, we have done more damage to the environment than any other civilisation in history.

The Antikythera mechanism is the culmination, we might argue, of Greek civilization that lasted some 350 years. In many ways though, the Antikythera mechanism is a result of a much earlier imagination. It makes use of mathematics and astronomical observations of the previous five thousand years, mostly from the even more ancient culture of Mesopotamia. Somehow, in both Ancient Greece and earlier Mesopotamia, civilisation was sophisticated, consumer goods were freely available, and yet the extremities of rich and poor, and the externalities of pollution and resource depletion were not as extremely problematic as in the Keynesian era. The Antikythera mechanism marks the boundary of one type of world with the other. It signals the future of technology, and yet remains firmly embedded in the pace and earth centric world view of the Axial civilisations. Instead of viewing modernity as the culmination or apex of human culture, it is useful to try and understand how these ancient cultures were so successful for so long.

**Mathematics and the Antikythera Mechanism**

Interestingly, by the time the Mechanism was made, probably around 206 BC, the Ancient Greeks were already speculating that the older view that the Earth is the centre of the universe, was inaccurate, and that the sun was actually the centre of the solar system. Furthermore, Carman and Evans argue that mathematics had taken on important new developments, from the geometry that dominated earlier mathematics, to trigonometry and prototype derivative equations. In contrast, the Antikythera Mechanism is based on very sophisticated understanding of the orbits of the planets, the sun, and the moon. But it remains earth centric. It also is firmly rooted in geometric mathematics rather than the new types of trigonometry.

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What has survived of the Antikythera Mechanism is 30 cogs (in part or full).\textsuperscript{25} Scholars estimate there were probably originally another 30 cogs. These cogs accurately replicate the elliptical orbit of the five known planets and the sun and moon. On the front face is the annual cycle of the sun and the moon, including a small ball that turn to show the phases of the moon. On the back of the Mechanism, are two large dials. One shows the Metonic cycles which is when the lunar and solar years coincide, in modern terms every 235 months long (or 19.5 years). The other is the Saros cycle of 223 months or 18 years. It predicts solar and lunar eclipses, including script describing the colour of the eclipse, and the ‘wind’ or climatic conditions likely to be associated with it.

There is a lot of speculation on what use the Mechanism was designed for. An indicator is how it calendars when and where the Olympic Games will be, in the tiny writing on the surface of some cogs. The huge emphasis on the cycles of the sun and moon on its front face raises other possibilities. Lunar and solar eclipses and comets were very important events in Ancient civilisations, and were seen as bad luck. Predicting them gave some control over the portents of future events.\textsuperscript{26}

The accuracy of the Antikythera Mechanism was not in the same order as the efficiency that underpins consumerism, progress, and economic growth. It is not the short minutes and hours of a day, that the clock is concerned with, but rather much longer cycles than can be ascertained by the seasons or even calendar years. The Antikythera Mechanism maps out the large scale cycles of the solar system. Some of the orbits take about 500 years. It was as ‘universal’ as the Invisible Hand. The Mechanism holds a pivotal role at the apex of Ancient civilization and as the prototype of modern machines. Yet it in no way signifies the consumerist ethos of modernity and instead directly represents another type of cosmology, a worlding of a culture that acknowledged the primacy of the cosmic order throughout its civic events, its economy, and its relationships with the earth.

**Time, economics, and ecology**

While ingenious in its mechanics, incredibly sophisticated in its mathematics, the Antikythera mechanism was already ‘out of date’ in its knowledge of trigonometry and the pivotal role of the sun rather than the earth. I want to argue that this was no accident, and the intent of the mechanism was for political purposes rather than up to date representation of the latest science.

Ancient Greece, Crete, Mesopotamia, Egypt, and Ancient China, and even as far as the Inca in Peru, all held similar, earth centric views of the world. All these cultures used the stars to govern the pattern of ceremonies and civil events. They held eclipses and comets as ill omens, and they recorded their cycles meticulously. The Antikythera clock took the work of

\textsuperscript{25} The way that these cogs have been analysed is itself fascinating. Hewlett Packard built an MRI machine especially for it, which was delivered to the museum and which enabled scholars to see ‘inside’ the mechanism with remarkable accuracy.

divination and gave it a more methodical dimension. It meant leaders had direct and meticulous knowledge of when was a good time to set events.

Ancient Greece, akin to Mesopotamia before it, had most of the *accoutrements* of what we now think of as ‘modern’ civilisation. They had knives and forks, pots and pans, indoor toilets, plumbing, roads with road rules, artificial light, and consumer goods for sale. Yet economic growth was *not* the model in use. Rather the opposite; the Sophists admonished people not to consume more than they need, the philosophical life was the simple life, and the ascetics of hermetism was much admired. In Ephesus on the main street there remains a large stone street sign, demanding people live a simple life rather than over-indulge.

While there is no doubt that Ancient Greek culture, like Mesopotamia and elsewhere, was a class society, they were cautious not to create excessive disparity between the rich and the poor. It was a culture that took slaves in combat, and held debt slaves. Citizens were limited to land owning classes, and only men. Nevertheless, the whole ethos of democracy, egalitarianism, and ethics itself counteract the tendency towards enabling the rich and powerful to make rules that further concentrate wealth.

Jo Marchant argued that the Antikythera mechanism was itself one of these luxury goods, presumably destined to gather dust in some wealthy family’s *Wunderkammer*. In my view, the Antikythera mechanism was not merely a curiosity. The Antikythera mechanism was, as Heidegger put it, *worlding*. It might be the first technical analog computer, the precursor to all modern machinery. But it was deeply embedded in the cosmological order of the Ancient world. It reinforced and relied upon the cyclic approach to time in terms of public events, regulations, economics, and legislative governance. An earth centred, cyclic approach to regular governance is a vastly different world view from the consumer model of teleological progress and economic growth.

To better understand this argument its necessary to go further back than Ancient Greece, to the culture where the mathematics and cosmological order evoked in the Antikythera mechanism originated. Mesopotamia had a consistent civilization for 5000 years. It is the origins of writing, accounting, and debt. They had a large population in a fragile ecosystem, and despite a well managed state and market, did not allow consumerism to grow exponentially and overwhelm the parameters of the local ecology.

**Mesopotamia**

The city state of Uruk is one of the oldest cities on the planet. Mesopotamia is a series of small city states, between two great rivers, the Tigris and the Euphrates. It is a delicate river delta, prone to drought, and the people there were very early to develop sophisticated irrigation systems. However, over-irrigation causes salt to come to the surface of the soil, so the levels of irrigation need to be carefully measured and governed.

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27 Jo Marchant. “The world’s first computer may have been used to tell fortunes” (2016).
Mesopotamia is one of the first known civilizations to develop. They have left behind a vast number of clay tablets, mostly covered in accounting debts, but also literature, astronomy, and legislation. It was the first ‘market’ economy, with strong state regulation of debt, interest and normative expectations of productivity. Cuneiform script developed initially as recordings of debts that were imprinted in clay, and then wrapped in a clay envelope. The scribes recorded accurately the number of goats, sheep or cattle loaned from one person to another and the expectations of stock, including offspring (or ‘interest) to be expected at a particular date in the future. Interest rates were based on norms of productivity. Accidental losses or risks were not included, and there were frequent cases of people being unable to repay their debt. The society had debt slaves until their debt was repaid, and debt was passed down through the family if someone died.

Just like modern economics, economic growth was built into the system. In Mesopotamia, the increase in stock numbers, for example, creates an irreducible economic growth. In the arid, carefully irrigated river delta, increases in stock numbers were quickly insupportable. The limits to growth were immediate and notable. Mesopotamia sustained civilisation for over 5000 years, so they understood and had very good mechanisms built into their system to alleviate economic growth and commensurate ecological disaster.

In order to offset the gradual increase in economic growth, we know that the Kings of Mesopotamia held periodic ‘misharum’ or debt jubilees. Debt jubilees were important elements of governance in Judaic, Early Christian, and Muslim societies. In Mesopotamia, these were held whenever the King died; all debts were null and void, and debt slaves were released (although other slaves were not).

Some Kings lead such long lives that they needed to introduce occasional debt jubilees during their reign. Otherwise the delicate ecology of the river delta would suffer from over-grazing, over-watering, and salination. All the misharum we know of, are collated in the box above28 although it is highly likely that there were others, but the tablets recording them have been lost. What

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is notable though, is the lack of consistent periodisation between debt jubilees. The irregularity, I would argue, was essential to the success of the jubilee.

How these important events were decided is unclear from any of the thousands of tablets that have been deciphered. We do know that Astrology was very important in Mesopotamian culture, and that Astrological charts were written by the Priestesses for important persons. They had incredibly detailed knowledge of the stars and their periodic cycles, of the lunar and solar eclipse, and of comets such as Halley’s Comet. Like the later Oracles, referred to by the Greeks, it seems that the Kings in Mesopotamia consulted with the religious bodies, to find good omens and good timing for important public events. For example, the following is a quote from a tablet in the Akkadian period, from astronomers, addressing the King;

An eclipse of the moon and sun in Sivan (iii) will take place. These signs are of bad fortune for Akkad, for the kings of Westland and of Akkad; and now, in this month of Kislev (ix), an eclipse will take place.²⁹

Thus, while I have to speculate from lack of overt evidence, it seems likely that the misharum were assigned according to astrological timetable.

It would have been important that the dates were unpredicatable to the general public, or rich lenders would recall their debts before the jubilee was called. As it was, people must have only been a lender if they could afford to lose it all, and the jubilees must have been a great equaliser of the population.

The complex elliptical orbits of the planets, and the omens that could be made of astrological signs were likely to have played an important role in deciding appropriate times for all major civic events, including the jubilees. The episodic knowledge and mathematics to predict eclipses, and other astronomical events were held by the Priestesses. While it must have been annoying for wealthy individuals who lose their assets in a debt jubilee, the overall outcome was to inhibit economic growth and reduce the risks posed by resource exhaustion, pollution, and as we are now experiencing today, greenhouse gas emissions and climate change.

All debts were annulled, and so instead of exponential increase, the jubilee created a general cyclic periodisation of loans. The sacred debt jubilee resets the economy and the tendency towards growth is cleared back to zero, consciously reducing the stress of continuous expansion of resource use. Presumably the expectation of returning the original quota of livestock along with their offspring was annulled. So the continuous expectation of the expansion of livestock from a debt obligation was eliminated to nothing.

Other than the King himself, debt jubilees create a systemically radical egalitarianism, of a deeper and more far reaching kind than the Keynesian Settlement. Universal education, healthcare, and the expectation of 2-3% growth per year has co-opted working class people into the modern form of capitalism. Mesopotamia’s capitalism had less welfare provision, but also no possibility for an extreme polarization between rich and poor. Cyclic debt jubilees

create a type of ‘steady state’ economics, with no concept of necessary progress, or necessary exponential growth. It is an economics that remains tightly embedded within the ecosystem. As the whole system of debt developed, exponential growth was clearly recognised as a danger, and eliminating it was the aim of good leadership. The technological *Gestell* at play in Ancient cultures related intricately to a cosmology of cyclic seasonal growth. Although urban areas tended to ‘forget’ the constraints of ecological conditions, these freedoms were regarded as fraught, and not allowed to take over. By remaining earth centric, Mesopotamia, and arguably the later Antikythera mechanism, allowed a sophisticated ‘proto-modern’ lifestyle to be maintained, over many thousands of years while holding up alienation as a live danger, not an invisible externality of the economic system.

Unlike the 250 year epoch of modernity, which, starting with coal, and then oil, has released more greenhouse gas emissions in a short period than since the dinosaur extinction. The ‘freedom’ of modern technology through the understanding of all things as ‘standing reserve’ for potential consumerism means we are largely unaware of local, national, or even global ecological conditions. When local disasters occur, people trade their way out of the danger. The Keynesian legislation for economic growth means that at present consumerism has risen to some 70 billion tonnes of product, and with it, billions of tonnes of CO₂e emissions.

The Kings of Mesopotamia planned nation wide debt jubilees. In contrast, modern economics has unplanned periodic economic collapses. The first was the collapse of the stock market in 1929, followed by a similar stock market crash in 1987, and then the housing bubble burst in 2008, and now we have a looming stock market futures derivatives threatening to crash any minute.\(^{30}\)

In the 1990s, the connection between economic growth and consumerism, and greenhouse emissions was clearly understood at the UN Cops on Climate Change and UNEP.\(^{31}\) In response, the idea of ‘decoupling’ economic growth from ‘stuff’ and instead tying it to the Knowledge Economy was mooted. This miraculously enabled growth without emissions. In response, education was seen as a prime site for the ‘Knowledge Economy’, but more significantly, ever more complex financial mechanisms have been developed, as the best minds find ingenious ways to create money out of ‘futures trading’ rather than today’s tangible products. A good example of these were the ‘risk free’ complex derivatives packaging of buying and selling aggregated mortgages across multiple banking lenders in the 2000s. Another mechanism is betting on interest rates. In 2016, the International Bank of Settlements estimated that the derivatives markets is worth an estimated 20.7 trillion US dollars. That value is 1% of the ‘notional’ value of the packages (as 1% deposits get traded but the full worth is 100 times more). Indeed its worth quoting them to get the scale of the issue; “The gross market value of OTC derivatives – that is, the cost of replacing all outstanding contracts at current market prices – rose to $20.7 trillion at end-June 2016 from 14.5 trillion at end-2015.”\(^{32}\) Thus the notional value of the derivatives market by October 2016 rose from $14 quadrillion to $20 quadrillion. Global GDP at the end of 2015, according to the World Bank, is 74 trillion.\(^{33}\)


\(^{31}\) UNEP International Resource Panel. (2016.)


disparity between these two numbers demonstrates that the derivatives market is sheer speculation, entirely alienated from the ‘real’ world altogether. The best illustration of Heidegger’s technological Gestell thus far. When this crash comes, it will possibly destroy the financial system altogether, finally wiping the scale of modern economic system to null, and enabling us to begin again. The danger is, as in 2008, that we have no conception of an alternative system ready and waiting to be put in place. That void allows the speculative bankers to persuade governments to back up their existing system time after time with taxpayer funds.

The debt jubilees of Mesopotamia are likely not a solution in modern times. Our worlding is of another order. But the earlier earth centric system referred to by the Antikythera mechanism, and the sophisticated calendars of all Ancient cultures indicates that systematised steady state economics is a real possibility. It creates the conditions for long term, genuinely sustainable civilisations.

Climate change demonstrates that the existing system of economic growth is immensely destructive. The boom and crash of the stock market is getting worse, and there appears to be no adequate rethinking taking place about the role of financial banking institutions. Resource exhaustion, pollution, and extremes in wealth and poverty are all symptoms of a system that is ethically and materially exhausted. The purpose of this paper is to show that in the past, there have been very effective mechanisms to maintaining long term civilisations with built in adaptations to eliminate the dangers of economic growth and ecological alienation. These two elements need to be the core factors in reworking rules for government legislation, corporations, the banking industry, and the stock market. Rather than ‘decoupling’ ‘alienation’ or ‘freedom’ from the constraints of ecology, we need to embrace the pace of planetary ecology as the grounding force for our economic systems.

The Antikythera mechanism illustrates that it is not the mechanisation or the ‘progress’ of technology that is the problem, it is, as Heidegger pointed out in “The Question Concerning Technology” the complete enframing of all aspects of society and ecology as ‘standing reserve’ waiting in the service of consumerism. Combined with exponential growth curves, and population growth (which I refrained from discussing in this paper) we are tied into a form of economics that is increasingly ‘decoupled,’ ‘freed’ or ‘alienated’ from the ecological realities of the planet. The Antikythera mechanism is a prime example of another kind of technological worlding, one that is earth centric (albeit a flawed notion of the solar system), and one that firmly ties economic performativity to the constraints of ecology, while enabling global trade, sophisticated consumer goods, and a fairly ‘modern’ lifestyle. The debt jubilee is just one element of this earth centric world view, but it illustrates very well that there are plenty of alternatives, and that the economic model and the type of world that we are embedded in is only one possibility amongst multiple. We have the need to change, and the scope to change. Now what is necessary is to develop the ideas and context for change to take place and education is an important site for doing this.

**Post growth and educational futures**

Education tends to focus on curriculum areas, theory of pedagogy, and policy and funding regimes. But the context of Brexit, of Trump’s warlike anti-immigration stance, of post 2008

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austerity measures, of climate change and sustainability discourse, and the drop in the oil price, all impact directly on what is possible within education. What’s more, education has a reciprocal role to play in this context. We forge the pathways to the future. Along with the media, education is the key site for cultural reproduction and transformation.

At present, while resistance is rampant all over the world, the neoliberal paradigm dominates education in most countries. Neoliberalism typifies the technological Gestell. It sets up students as ‘clients’ that are getting summative qualifications to ‘add value’ to their ‘human capital’ so they have transferable skills that can be leveraged on the market’s workforce. None of this has any concern for the human being, the emotions or wellbeing of the person, or of the environment they live in. There is no real engagement with the community unless its as consumers or potential employers. The contemporary technological worlding that alienates us from our environment, from our community, and even from our selves dominates the educational framework at almost every level.

There are plenty of examples though, of education thriving in much more holistic ways than that dictated by the neoliberal system. Schools with outdoor education programmes, with gardens, with engagement with refugees, or other community based facilities. Schools in Sweden which have a holistic curriculum, and emphasise formative rather than summative assessment. Schools that are Learning Centred, rather than Authoritarian or Student Centred. There are many examples of schools going well beyond the dominating enframing of standing reserve for consumerism.

The next step is to enlarge and highlight the discourse that puts the environment and its health at the centre of all our endeavours. We do not have to believe that the planets revolve around the earth, to be ‘earth centric’. An earth centric ethos would help to shift the enframing of modernity from alienation to one of global embeddedness. When we teach students these kinds of ideas, and enable a critique of the current model, we prepare the ground for deep set change. Its not prescriptive, but it is foundational change. It will help students and their families to expect more from economics, from governance, and from corporations, and to create limits that are based on ecological and social health, so that the system stops spinning out of all relation to reality. The example of the cosmic ordering in Ancient cultures, and the debt jubilee that limits economic growth and allows thousands of years of steady state prosperity is a good example that these changes are possible, that new systems are possible, and that education is a key player in creating a population that demands these new ways of knowing and becoming.