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# Forecasting the next major thrust into space

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**Patterns in societal energy use enable forecasts of the times of future events associated with important human exploration and technology programs. Discovered in 1989, the 56 year energy cycle has previously been linked with many technological, economic, and social parameters. A review of the last 200 years reveals that major human explorations (e.g. polar expeditions), macro-engineering projects (e.g. Panama Canal), and large wars (e.g. World War I) cluster together in time near energy cycle peaks approximately every 56 years. The energy cycle and several other indicators suggest that large-scale human operations in space will begin to appear around 2015. They should culminate in a space spectacular near 2025. Another window of opportunity for space exploration will not open until late in the twenty-first century.**

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Although one has to be at least thirty-something to remember it, there once was a time when humanity's golden dreams of space colonization were not only politically correct, but the first few steps at least, were momentarily *actualized*! In the quarter of a century since the Apollo Moon program, the political climate for major space ventures beyond LEO has been rather negative, partly because the international forces which drove Apollo do not exist in today's world. Thus a key question arises: is aggressive, Apollo-style space exploration unique for all time? Or will another lofty epoch arrive sometime in the reasonably near future when humanity will take the *next* giant step into space, involving, for example, permanent human settlements on the Moon and/or Mars? Most importantly, *when* will this occur?

Because of this topic's importance, numerous space planners have speculated about it. For example, as part of a study done at General Dynamics in 1988, Otto Steinbronn and I[1] concluded that 'it is highly probable that a major space venture will occur in the next 20 years.' We offered a variety of convincing budgetary, historical, international, strategic, and operational justifications for this belief, but like most others, it was fundamentally intuitive and nonspecific in its estimate of the actual timeframe.

However, this article makes and supports specific forecasts about the *timing* of pivotal future space exploration activities. The forecasting technique and a few of the supporting arguments are motivated primarily by the recent work of physicist Theodore Modis[2] (Geneva, Switzerland). His, and several other fascinating studies show that: (1) regular periodic oscillations in US (and probably global) energy use are confirmed in official records over the last two centuries, and (2) these energy cycles are linked with a surprisingly wide variety of important economic, technological, and social phenomena.

Although space exploration is only briefly treated by Modis, several lines of evidence are developed here which support the idea that major historical episodes of human exploration – including those of space – are *likewise* closely correlated with the well-documented sinusoidal oscillations of the energy cycle. Thus hypothesized modern 'human exploration cycles' are calibrated by correlating the chronologies of major

[1]Cordell, B. and Steinbronn, O., An analysis of possible space strategies featuring the role of space resource utilization. *Acta Astronautica*, **26**, 1 (1992) 19–27.
[2]Modis, T., *Predictions*, Simon and Schuster. New York, NY, 1992.

human explorations in the past (plus macro-engineering projects and other events) with trends in the Modis energy cycle.[3] This fundamentally *empirical* approach allows space exploration forecasts to be obtained by extrapolating the Modis/human exploration cycles into the future and identifying the times of projected milestones.

This analysis suggests strongly that humanity *will* have another shot at colonizing space. And, although it is possible that harbingers of the next major thrust into space may appear around 2015 or even before, a variety of indicators suggests that the *culmination* of this next major step into space (whatever form it takes) should materialize *circa* 2025. In effect, the future analog of the 1960's Apollo decade is expected to be 2015 to 2025. However, societal support for space may fade rapidly after 2025. If Earth-independent space colonies are not established on the Moon or elsewhere by the mid-2020s, it is unlikely that humanity will experience another Apollo-style, expansive decade until late in the twenty-first century.

## Society rides a Modis Cycle

For those interested in the future, two of the most intriguing discoveries of recent times are that a 56 year energy use Modis Cycle actually exists and that numerous key societal activities regularly pulsate in harmony with it. Although Hugh Stewart[4] first specifically described the 56 year energy use cycle in 1989, several others have previously noticed that certain key economic variables seem to regularly oscillate with periods close to 60 years. Notable among these is the Russian economist N D Kondratieff[5] whose seminal studies in the 1920s and 1930s identified an economic cycle of 50 to 60 years. In his 1994 review of the literature, Barry Hughes[6] concludes that the evidence supporting such long period economic or technology development cycles is 'mixed', however he does not consider the data developed by Stewart, Modis, or others discussed below. For example, one well-known international economic theorist – Ravi Batra – has shown that four key economic indicators (e.g. money supply) indeed appear to oscillate with a 60 year cycle.[7] In support of Batra's intriguing ideas about economic and social cycles the noted economist Lester Thurow argues that 'one can learn a lot about events by thinking about them in terms of cyclical regularities . . . even if one believes that unique individuals and events are important.'[8]

The most impressive presentation that both clearly establishes the existence of the 56 year energy cycle and demonstrates its important societal connections is by Modis.[9] His graphs show conclusively that US energy use since 1840 is well-described as a sinusoidal oscillation with an amplitude of at least 20% deviation from the mean value and a period of approximately 56 years.[10] Modis also describes supportive evidence for his belief that 'the whole world may be pulsating to this rhythm', plus he speculates that the observed energy use oscillations are responding to an 'external stimulus' and probably have existed at least throughout human history.

A second key point involves correlations between the observed Modis Cycle and a diverse set of human activities. Modis displays several plots of technological, economic, and social parameters that appear to be pulsating in a way that is consistent with the Modis (energy) Cycle, however some are not in phase with it.[11] For example, plots of the number of 'basic innovations' – defined as something that starts a new

[3]The 56 year energy use cycle is referred to here as the 'Modis Cycle' in honor of Dr Modis' intriguing studies and discussions of it.

[4]Stewart, H.B., *Recollecting the Future: A View of Business, Technology, and Innovation in the Next 30 Years*. Dow Jones-Irwin, Homewood, IL, 1989.

[5]Kondratieff, N.D., *The long wave in economic life, The Review of Economic Statistics*, **17** (1935) 105–15.

[6]Hughes, B.B., *Continuity and Change in World Politics*. Prentice Hall, Englewood Cliffs, NJ, 1994.

[7]Batra, R., *The Great Depression of 1990*. Simon and Schuster, New York, NY, 1987.

[8]*Op cit*, Ref. 7.

[9]*Op cit*, Ref. 2.

[10]These energy pulsations are superimposed on a gentle S-curve of energy use growth that starts around 1850 and approaches its peak near the end of the twenty-first century at about 2.5 times today's energy use values.

[11]*Op cit*, Ref. 2.

industry or a new kind of product (e.g. the phonograph) – oscillate with a 56 year period all the way back to the mid-eighteenth century, hinting that the Modis Cycle extends at least a century farther back in history than the existing energy use data sets. However, the peaks of the innovation cycle coincide with the troughs (low points) of the energy cycle; i.e. they are 180 degrees out of phase with each other. The same is true of a 56 year cycle associated with the discovery of stable chemical elements.

Interestingly, bank failures likewise oscillate every 56 years but their peaks occur during the *declining* portions of the energy cycle.[12] This suggests that the Modis energy Cycle corresponds to a 56 year *economic* cycle, and that energy peaks are times of prosperity or 'booms' and energy troughs are the bottoms of major recessions. This view is buttressed by the clustering of expensive new subway projects in cities around the world every 56 years at the *peak* of the energy cycle. Plus, the global character of the subway data supports a *world-wide* Modis Cycle. Perhaps the zeitgeist of the growth/boom portion of a modern Modis Cycle is best characterized by historians John Harrison and Richard Sullivan: 'To a visitor from Mars it must have appeared that the Western world in 1914 was on the brink of Utopia.'[13]

Tragically, the apparent 'Utopia' of 1914 and the Stock Market both crashed in 1929 and triggered the worldwide Depression which lasted until 1939 – coincident with the 1940 energy cycle trough. The 1987 Stock Market crash is also instructive. For example, Batra[14] has found close correspondences between economic data and events – on a year by year basis – between the decades of the 1920s and the 1980s. Without any knowledge of Modis Cycles, Batra predicted a stock market crash toward the end of the 1980s followed by a severe economic crisis or recession ending around 1996. Of course, 1997 happens to be the bottom of the current energy cycle.

Recently Clifford Cobb and his colleagues[15] at Redefining Progress, a nonprofit public-policy organization in San Francisco, have asserted that the gross domestic product (GDP) is an inadequate barometer of economic conditions. They propose replacing it with their genuine progress indicator (GPI) which includes more than twenty aspects of the economy that the GDP ignores.[16] Interestingly, the GPI rises from the early 1950s and peaks in 1970 (a Modis peak); since then it has suffered a gradual decline of 45% to the present. This constitutes impressive, independent evidence that the Modis Cycle has mirrored changes in economic conditions in the USA over at least the last 45 years.

Technological and economic parameters are not alone in their 56 year dance with the Modis Cycle. Modis has shown that they are joined by a diverse group of social parameters including life expectancy, cirrhosis of the liver, records in the one-mile run, homicides, types of murder weapons, and others.[17] His data reveals that homicides fluctuate by a factor of two every 56 years and peak during energy cycle declines (recessions) when times are bad and people are stressed; the same is true of cirrhosis of the liver except that it peaks during the boom years when everyone is celebrating.

The bottom line is: (1) energy use in the USA and probably the world has experienced regular, predictable, appreciable oscillations every 56 years (Modis Cycles) for the last two centuries and probably much longer, and (2) Modis Cycles are closely correlated with similar 56 year cycles in the USA and probably around the world) in many important,

[12] *Op cit*, Ref. 2.
[13] Harrison, J.B. and Sullivan, R.E., *A Short History of Western Civilization*. Alfred A. Knopf, New York, NY, 1966.
[14] *Op cit*, Ref. 7.
[15] Cobb, C., Halstead, T. and Rowe, J., If the GDP is up, why is America down? *The Atlantic Monthly*, **276**, 4 (1995) 59–78.
[16] These include: the household and volunteer economy, effects of crime, distribution of income, resource depletion and environmental degradation, and loss of leisure.
[17] *Op cit*, Ref. 2.

yet disparate human activities in technological, economic, and social arenas.

## To go where no one has gone before . . . again and again

If Modis Cycles and their clear links to similar technological, economic, and social cycles are taken seriously, then an obvious question arises: are there *other* human activities with Modis-like Cycles that are currently unrecognized? For example, are there cycles in events associated with human exploration?

This is a reasonable question because anthropologists have firmly established that exploration – particularly exploration that is facilitated by technology – is quintessentially a *human* activity. Anthropologist Ben Finney[18] comments that:

> Homosapiens are by nature wanderers, the inheritors of an exploring and colonizing bent that is deeply embedded in our evolutionary past . . . What makes us different from other expansionist species is our ability to adapt to new habitats through technology . . . it allowed our distant ancestors to spread over Earth and now enables us to contemplate leaving our natal planet . . . Whereas technology gives us the capacity to leave Earth, it is the explorer's bent . . . that is leading us to the stars.

In essence, space exploration is just the lastest manifestation of a deep, long-lived human tendency to geographically extend one's sphere of physical operations. Until modern technology was invented space exploration was a physical impossibility, but other types of human exploration using then-existing technologies could and did occur. For this reason the human aspects of space exploration are more properly considered in the broader context of human exploration.

The broad swath that Modis-like Cycles cut across modern human experience and the biocultural centrality of human exploration throughout history, suggest that human explorations (and related events) should have visible Modis-like Cycles during at least the last two centuries. Confirmation of this suggestion is an essential step toward reliable, specific forecasts relating to the timing of major future thrusts into space.

The criteria used here to judge whether human explorations are socially significant are: (1) they feature the exploration of significantly *new* geographical sites, (2) for a variety of reasons, including competition, nationalism, and/or danger, the adventure captures the attention of a large audience (usually of national or global scale), and (3) typically the expedition is aided and/or enabled by the most modern technology available.

Using these criteria, the most recent epoch of significant human exploration is the Apollo Moon program of the 1960s. If our expectations about the intersection of the Modis Cycle with human explorations are reasonable we should expect an expensive program like Apollo to occur during an energy upturn and perhaps culminate at a peak. The first human landed on the Moon in 1969. Remarkably, this is the same year as the most recent energy cycle peak (see Figures 1–3).[19] There were six successful Apollo lunar landings, but only Apollo 11 (the first lunar landing mission) and the unsuccessful Apollo 13 (recently dramatized in an excellent movie), were really able to capture the attention of the global public.

[18]Finney, B.R. and Jones, E.M., The exploring animal, in *Interstellar Migration and the Human Experience*. University of California Press, Berkeley, CA, 1985.

[19]President Kennedy's speech officially inaugurating the Moon program was given in 1961 and the most active portion of the space age began in 1957 with the orbiting of Sputnik and the formation of NASA.

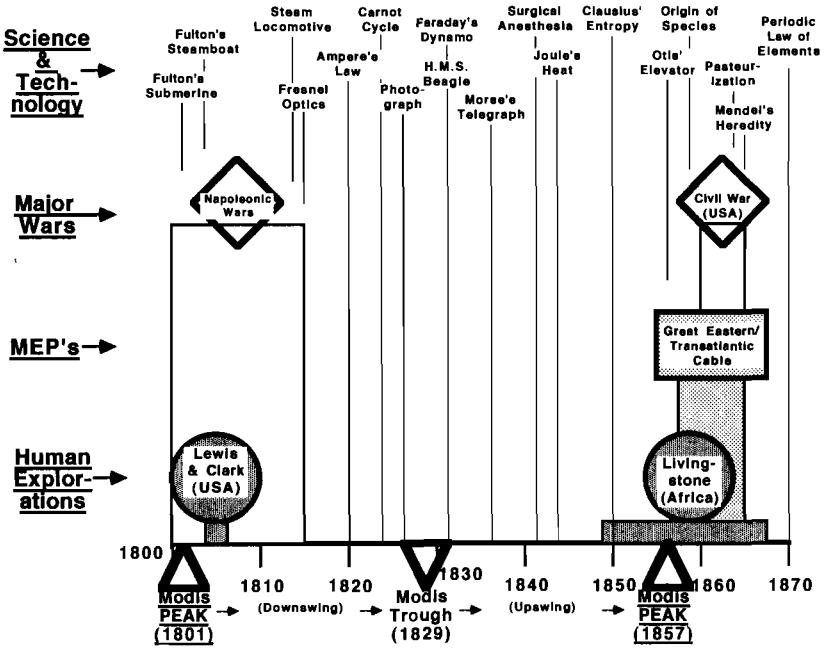


**Figure 1.** 1800–1870.

The Skylab space station of the 1970s and the initial Shuttle flights (starting in 1981) did not generate Apollo-level enthusiasms. Although important science and engineering advances abounded, the public perception of Skylab and Shuttle was one of replowing old ground and having no clear long-range plan. After all, numerous spacecraft had been orbiting the Earth since 1961 and there was no space station (or more distant destination) for the Shuttle to rendezvous with. After six grandious human strolls on the Moon's surface during 1969–72, being confined to LEO seemed anticlimactic, and it did not stir raw human exploration passions even approaching Apollo. In summary, the real magic of Apollo was threefold: (1) it had the most extraordinary destination in human history (it was off-world!), (2) it was the ultimate

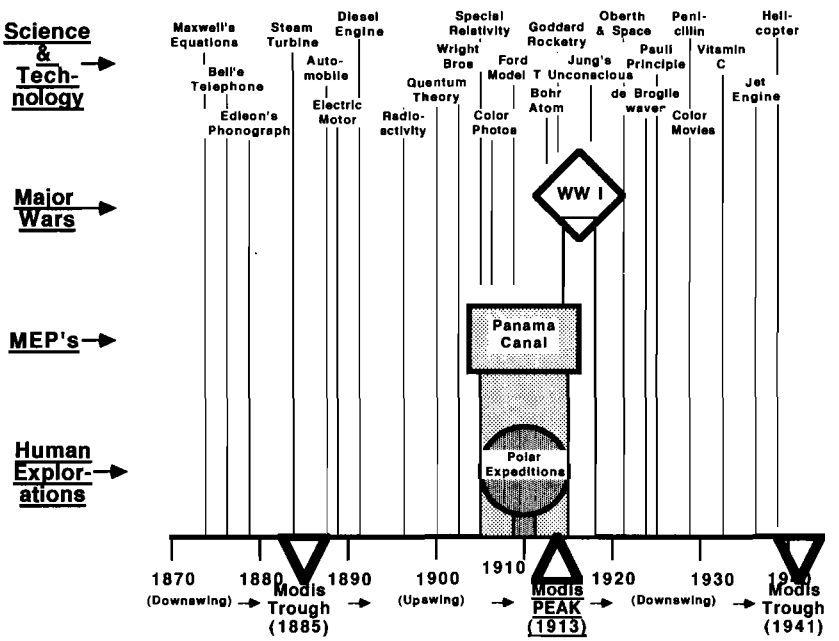


**Figure 2.** 1870–1940.

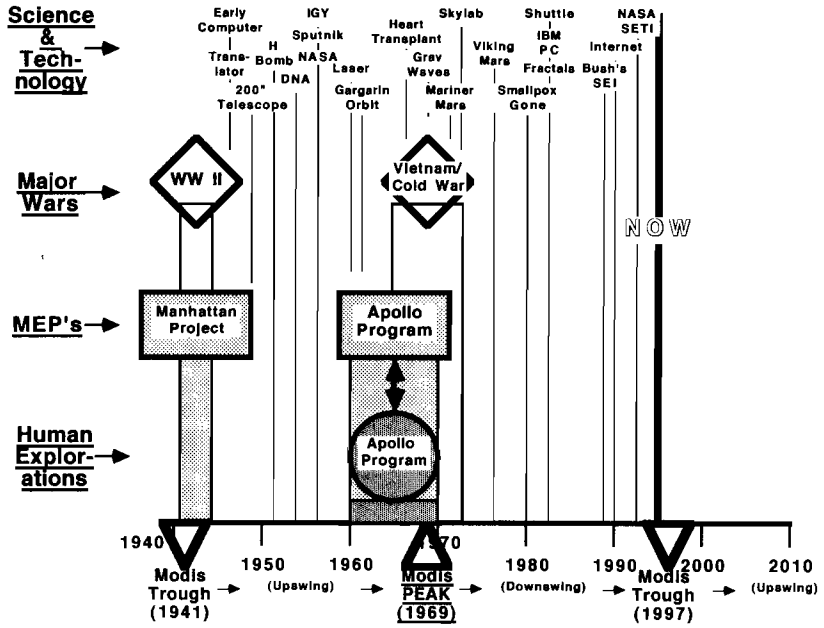


**Figure 3.** 1940–2010.

state-of-the-art, expensive, macro-engineering project (MEP),[20] and (3) just for good measure, Apollo married modern science to the greatest exploration and technology event in human history!

Any good forecasting tool must also be able to 'predict' the past. Thus Apollo's links to the 1960's growth/boom portion of the Modis Cycle suggest that the next major human exploration events might be expected 56 years earlier, shortly before the energy peak of 1913 (see Figure 2). Indeed, no major human exploration events (as defined previously) are evident in history between Apollo and 1913. At this time, the only significant terrestrial regions left unexplored were near the poles. Polar regions were particularly alluring to explorers because they were dangerous and inaccessible. Perhaps the most symbolically significant polar milestone was in 1909 when Robert E Peary became the first person in history to reach the North Pole of the Earth. The South Pole was first attained two years later by Roald Amundsen. One measure of the global significance of Peary's adventure was that even 45 years later a distinguished panel of scholars and writers judged it to be one of the top 100 historical events of all time.[21]

Physicist Freeman Dyson[22] and others have noted important parallels between the challenges and risks of the polar expeditions and those of late twentieth-century space exploration. Like Apollo, polar quests had: (1) intense international competition, (2) hardship, danger, and deaths, and (3) an exotic destination with considerable public appeal. One revealing similarity between polar and space explorations is the continuation of post-Modis peak exploration efforts when new technologies and systems became available. For example, in 1926 Richard E Byrd became the first man ever to fly over the North Pole. When compared to the drama and hardships of the initial dogsled polar expeditions, subsequent visits using airplanes were perceived as less exciting. The relatively low-public interest polar flights of the late 1920s and 1930s are apparently characteristic of the more subdued style of human exploration seen during descending (recession) portions of the Modis Cycle, at least during the twentieth century. They are analogous to the Skylab

[20]Ferguson, E.S., Historical perspectives on macro-engineering projects. In *Macro-Engineering and the Infrastructure of Tomorrow.* Westview Press, Boulder, CO, 1978.
[21]Nisenson, S. and DeWitt, W., *History's 100 Greatest Events.* Grosset & Dunlap, New York, NY, 1954.
[22]Dyson, F., *Infinite In All Directions.* Harper & Row, New York, NY, 1988.

and Shuttle programs during the currently descending Modis Cycle 56 years later.

## Westward Ho!

As one plunges back into the nineteenth century, unexplored Earth-based frontiers were more plentiful than today and so the amplitude of hypothesized human exploration cycles might be reduced. Because Europe itself had been thoroughly explored, one might expect that the hypothesized nineteenth-century exploration cycles of European nations (assuming they have Modis-like Cycles) might be more obvious than US cycles at this time. For reference, the mid-century Modis Cycle peak is in 1857 and its predecessor probably occurred in 1801 (Figure 1).[23]

In 1803 one of the pivotal events in world history occurred. Jefferson's purchase of the Louisiana Territory triggered an expansive era (until 1870) in which the USA was the fastest growing nation in the world, in both geographical area and population. Lewis and Clark explored much of the Louisiana Purchase between 1804 and 1806. The Lewis and Clark expedition was the first documented trip ever made across the USA over land to the Pacific Ocean. It opened the floodgates for colonists to expand toward the western part of the USA, and resulted in the USA becoming a bi-coastal entity. Lewis and Clark recorded detailed information about the flora, fauna, geography, geology, and inhabitants of this unexplored wilderness. Their published notebooks motivated and educated large numbers of people contemplating or making the trek west. The Lewis and Clark expedition is another very special example of an epochal pulse of human exploration coinciding with a peak in the Modis Cycle.

Seemingly endless settlers moved across the USA toward the Pacific *throughout* the nineteenth century. By 1840 the frontier was at the 100th meridian (near Dodge City, Kansas). The discovery of gold in California in 1848 and the subsequent westward expansion of railroads resulted in the effective closing of the American frontier about 1890.[24] Perhaps because of this more-or-less continuous exploration, the anticipated mid-nineteenth-century American exploration peak is very broad (compared to the twentieth century) and difficult to discern. However, elsewhere in the world this was not the case.

In particular, Europe was discovering Africa.[25] Although many Europeans explored Africa during the nineteenth century, one extraordinary explorer drew global attention. A physician and missionary, David Livingstone was born in Scotland and was one of the first Europeans to venture into the unknown wilds of central Africa. The whole world was enthralled by the travels of Livingstone. Although he started exploring in Africa in 1840, he captured the attention of the world because of his discoveries made between 1858 and 1864, shortly after the Modis peak in 1857. When Livingstone disappeared for a few years people everywhere became worried, and a New York newspaper sent a reporter named Henry Stanley to find him. Finally Stanley entered a village near Lake Tanganyika and reportedly blurted, 'Dr. Livingstone, I presume?' The fact that this phrase is well-known even today is testimony to the impact Livingstone's adventures had on the global public. Because of Livingstone's: (1) ability to attract high global interest (including his disappearance), (2) exploration of exotic, new

[23]This date is inferred from Modis-like 56 year cycles that extend back into the eighteenth century; the specific energy use data that establishes Modis Cycles ends around 1840.

[24]Barraclough, G. (ed.), *The Times Concise Atlas of World History*. Hammond, Maplewood, NJ, 1982.

[25]*Op cit*, Ref. 24.

geographical sites, and (3) successful confrontation of life-threatening dangers and challenges in unknown Africa, his adventures are considered to be peaks in the (hypothesized) international human exploration cycle.

In summary, this section has identified convincing historical evidence for the existence of a human exploration cycle over at least the last 200 years. It has a 56-year Modis-like period, and importantly, major human exploration events cluster near energy cycle peaks; this is similar, for example, to the way twentieth-century urban subway projects also cluster near Modis peaks. The Modis-like exploration cycle appears to be global.

As seen in Figures 1–3, four Modis Cycle peaks are known between the present and 1800. All four energy peaks during the last 200 years are associated with monumental human exploration events of great public interest. They are: 1969: the Apollo Moon program (1961–72); 1913: Perry's North Pole expedition (in 1909); 1857: Livingstone's central Africa adventures (1848–64); 1801: the Lewis and Clark expedition (1804–6). The mid-nineteenth century does not have an obvious exploration peak associated with an *American* (Livingstone was Scottish), probably because the general, continuous western trend of large numbers of settlers may have obscured it. Nevertheless, the fact that many of Livingstone's admirers were in the USA indicates that Americans were *vicariously* caught up in his explorations, much the same way they were with Neil Armstrong in 1969 and with Admiral Robert Peary sixty years earlier.

After the close of the American frontier in 1890, peaks and valleys in the human exploration cycle in America are easier to discern presumably because geographical frontiers became increasingly scarce or inaccessible. Thus until the 'Lewis and Clark' of interplanetary space arrives (i.e. triggering the migration of hoards of Earthlings into space!), it should be relatively easy to forecast major human exploration peaks in the future, assuming the Modis Cycle extends into the twenty-first century.

## Bigger *is* better

The existence of a hypothesized 'human exploration cycle' (associated with Modis Cycle peaks) is impressively supported by evidence for other recent types of major technological and social events with their own observable Modis-like cycles. Figures 1–3 reveal that although significant breakthroughs in science and technology can occur at any time, MEPs[26] (Macro-Engineering Projects) seem to cluster near *peaks* of the Modis Cycle.

Because of the *psychocultural* significance of MEPs throughout history,[27] it is not surprising that modern MEPs display a Modis-like cycle. Indeed two of the diagnostic characteristics of an MEP – great cost and state-of-the-art technology – suggest strongly that MEPs should be associated with booms and peaks in the Modis Cycle, which is confirmed by Figures 1–3.

An Apollo-type model of human activities during ascending portions of the Modis Cycle might lead us to expect that humans would initiate an MEP even if it is not conveniently associated with the major thrust of human exploration at the time. Indeed the Panama Canal opening in August, 1914 fits this expectation. Although less expensive than Apollo,

[26] *Op cit*, Ref. 20.
[27] *Op cit*, Ref. 20.

the Panama MEP was begun in 1907 and required the solution of unprecedented problems in several areas. Its magnitude, duration, and management challenges are quite analogous to Apollo which occurred exactly one Modis Cycle later. However Panama didn't involve human exploration. Apparently the human exploration urge prior to the 1913 Modis peak was gratified by Peary and the polar expeditions.

The mid-nineteenth-century Modis peak was marked by a dual MEP involving the laying of the first trans-Atlantic cable and a gargantuan, relatively useless ship called the Great Eastern.[28] Because of its extreme size and weight, the Great Eastern was a failure for transporting passengers, but it was the only ship large enough to carry the quantity of cable required to span the Atlantic (which it was not intended for). Like the early twentieth-century Peary Peak, mid-nineteenth-century major human explorations by Livingstone were physically separate from the MEP.

In summary, the last three exploration peaks in history were all accompanied (at least in time) by MEPs. While the Peary and Livingstone explorations did not physically involve their MEPs, Apollo integrated both MEP activities and explorations into the greatest human project of all time. Only the early nineteenth-century Lewis and Clark peak did not feature an MEP at all. These intriguing facts and the explosive revolution of technology from Lewis and Clark to the present indicate a convergent trend in the relationship between the increasing demands of human exploration and future MEPs. If the integrated exploration/MEP Apollo experience can be reliably extrapolated, twenty-first-century Modis peaks are likely to feature brief, but spectacular human exploration activities and MEPs that are thoroughly intertwined in the *same* macro-projects.

## Modern wars cluster at Modis extrema

In terms of their immense expense, great challenge, and forced use of new technology, modern wars have some things in common with MEPs. However, their appalling destructiveness (in both lives and property) sets them apart. Nevertheless it is quite interesting that two of the three major wars within the last 200 years – Civil War and World War I – occur at Modis peaks, while World War II occupies a Modis trough.[29] The fact that modern wars are correlated with the Modis Cycle again buttresses this paper's conclusions and a brief discussion is warranted here.

Modis[30] asserts that *chaotic* behaviour of social and economic systems is likely to be confined to periods of technological and economic saturation, i.e. near Modis Cycle peaks and troughs. Bak and Chen[31] have shown that chaotic systems continually organize themselves into a critical state in which a minor event precipitates a chain reaction that can lead to a catastrophe. Examples could potentially include economic or military cataclysms (i.e. wars). Chaos as a trigger for war is supported by several historians' accounts of unusal conditions during some prewar periods[32] which, during a timeframe characterized by chaos, could easily explain the occurrence of relatively minor, random events (e.g. an assassination) that might quickly lead to war. However, during times of growth or recession (away from Modis troughs), social and economic systems would be less likely to propagate such potentially tragic chaotic fluctuations.

[28] *Op cit*, Ref. 20.
[29] Even the Napoleonic Wars were roughly centered on the Lewis and Clark exploration peak. This is to be expected if wars are somehow linked to the Modis Cycle and the cycle is indeed global.
[30] *Op cit*, Ref. 2.
[31] Bak, P. and Chen, K. 'Self-organized criticality. *Scientific American*, January (1991).
[32] E.g. Van Doren, C., *A History of Knowledge*. Ballantine, New York, NY, 1991.

Thus major wars like World War II might theoretically be expected near troughs of the Modis Cycle. However, this model does not explain why, during the last 200 years, major wars have occurred near every Modis peak and only at one trough, although this may be related to societal affluence.[33] Nevertheless, the historic chain between the Manhattan Project, the development of the Cold War and Vietnam, and the genesis and termination of the Apollo program, illustrates important connections between World War II and manned space exploration, and thus World War II is of direct relevance to our ability to use the Modis Cycle to extrapolate future space surges.

Perhaps the best approach to briefly resolve this mystery is to be empirical. Figures 1–3 show that Apollo was the only exploration peak in the last 200 years that followed a major war near the preceding Modis trough. An optimist would conclude that: (1) these historical facts and the end of the Cold War (plus a variety of geopolitical and other factors) would make a major war near the current Modis Cycle trough (1997) rather unlikely, and (2) a major war in the next few years is probably not required to stimulate major human exploration/MEP events expected around the 2025 peak.

## Penetrating Kondratieff

The 'Kondratieff Barrier' refers to the challenge facing a society which has declined to its Modis trough (such as ours), and is attempting to rebound upward in its economic cycle. This paper has implied that the Kondratieff Barrier must be penetrated if we are to ever again achieve the economic conditions and social attitudes conducive to major human explorations.

There are several reasons to believe that our current Kondratieff Barrier will be penetrated. Perhaps the most convincing is the history of the last 200 years. Ample historical data (some quoted earlier) indicate the Modis Cycle and its economic, technological, and social echoes have faithfully pulsated with a 56 year period over the last two centuries, and probably much longer.[34] There is no reason to believe that the Modis Cycle will be interrupted now. Indeed, five specific reasons to expect that it will continue into the twenty-first century are:

(1) Some of the old industries are still viable and will provide economic momentum through the barrier; these include electronics and computers, natural gas pipelines, nuclear power stations, and subway transportation infrastructures.[35]
(2) A couple of young industries – air route connections and pollution abatement – will encourage trans-barrier economic growth.
(3) New commercial transportation technologies – supersonic airplanes and Maglev trains – are poised to potentially become the new transportation workhorses[36] of the twenty-first century.
(4) The birth of the Information Age, manifested by very common access to Internet and other global communications technologies, quickens our responses to events and has immense potential to influence commercial and cultural practices.[37]
(5) The Modis Cycle may be *externally* driven (e.g. by solar variations?) and may not be subject to terrestrial influences; e.g. it appears to have extreme longevity (several centuries?), to be

[33]Modis, T., Personal communication, 1996.
[34]*Op cit*, Ref. 2.
[35]*Op cit*, Ref. 2.
[36]Each modern Kondratieff Barrier has been marked by the succession of a new transportation industry over an old one (e.g. roads over railways).
[37]Gingrich, N., *To Renew America*. HarperCollins, New York, NY, 1995.

global in its extent, and to be amazingly diverse in its societal influences.

## Beam me *up* (?) . . . Scotty

This paper has made a case for the existence of human exploration pulses that cluster around Modis Cycle peaks and are likely to persist well into the twenty-first century and beyond. However, it may not be obvious to all that the early twenty-first century Modis peak (in 2025) will most likely feature explorations and MEPs involving humans in *space*.

One argument supporting the case for space is simply that it is the only exciting, unexplored place left to go. The power of this point is exemplified by the fact that one doesn't need to be familiar with Modis Cycles or be a space expert to see it. For example, back in 1976 futurist Herman Kahn of the Hudson Institute identified 1996–2025 as the time of 'the first serious move to colonize space.'[38] Another non-space scholar has described the onset of space colonization in this timeframe as 'the beginning of what may be mankind's greatest epoch.'[39] To others more acquainted with the awesome opportunities and pristine destinations awaiting in space it's self-evident that 'The stars are our destiny . . . (and) we must act quickly.'[40]

Another reason favouring space as the focus of human explorations and MEPs as we approach the 2025 Modis peak involves environmental crises that continue to afflict the Earth.[41] Although often overstated and misunderstood, these problems – particularly in the areas of environmental pollution, population, and energy – are very real and threaten our prosperity in the twenty-first century. Views of Earth from space have already been symbolically and scientifically useful in this task, and hold even more promise as our studies of regional and global change intensify. As the technologies associated with space colonization[42] – solar energy, extraterrestrial resource use, lasers, and others – become increasingly developed toward 2015, it will become even more obvious that Earth's environmental challenges can be best solved using space technology and resources.

## Wildcards

There are a few possibilities of potentially monumental importance that would also point to space as our early twenty-first-century focus. Although each is highly speculative and shrouded in considerable uncertainty, they deserve our brief consideration because of their potential societal impact. The list of future wildcards includes:

(1) Extraterrestrial life and/or artifacts are discovered, using the Hubble Space Telescope, planetary spacecraft, or radio telescopes. If the ETs are intelligent and located in our solar system an explosion of global interest in space exploration would ensue. Because our planet has been leaking radio and TV broadcasts for 60 years to nearby stars, Robert Jastrow and others have suggested that the early twenty-first century is a reasonable time to expect a reply if nearby ETs exist.[43]

(2) A major episode of social change results in a sociopolitical climate favoring grand human explorations. Although seemingly farfetched, this is exactly what economist Ravi Batra expects based on Indian scholar P.R. Sarkar's law of social cycles.[44] Batra sees our

[38]Kahn, H., *et al*, *The Next 200 Years*. Morrow, New York, NY, 1976.
[39]*Op cit*, Ref. 32.
[40]Savage, M.T., *The Millennial Project*. Little, Brown and Co, New York, NY, 1994.
[41]Gore, A., *Earth in the Balance*. Houghton Mifflin, Boston, MA, 1992.
[42]Criswell, D.R. and Waldron, R.D., International lunar base and lunar-based power system to supply Earth with electric power. IAA-91-699. 42nd Congress of the IAF, Montreal, October 1991.
[43]Jastrow, R., The case for UFOs. *Science Digest*, Nov/Dec (1980).
[44]*Op cit*, Ref. 7.

current social malaise as leading to a social revolution in which wealth 'acquisitors' will be replaced by 'adventurer/warriors' as the dominant group in society. The adventurer/warrior spirit is what led the USA to send people to the Moon and could be expected to focus on the endless space frontier again. Based on the timing of Sarkar's cycles over the last 2000 years, this revolution could occur sometime between now and 2010.

Based on energy and technology cycles, Modis also refers to the late 1990s as a time of 'discontinuity . . . (where) profound social and institutional changes may be inevitable.'[45] Independent of both Modis and Sarkar Cycles, and yet within a space context, other scientists also forecast near-term trouble. Their concern is the public's widespread belief in UFOs and extraterrestrial life.[46] For example, computer scientist Jacques Vallee warns that 'The UFO phenomenon is a precursor of a major discontinuity.'[47] He believes that the failure of the government, science, and military establishments to deal effectively with the UFO mystery has eroded public confidence in these entities.

If a near-term Sarkar social transition produced the expected widespread 'adventurer' mindset, this could reenforce the return of economic growth and more buoyant attitudes expected during the upswing of the Modis Cycle. This scenario could result in the constructive channelling of the public's fascination with ET visitors from space into an exciting early twenty-first-century human space program.

(3) The relief of millennial fears for many after the year 2000 may lead to a new surge of optimism, productivity, innovation, and an interest in doing exciting, new things (like human exploration of the cosmos). One thousand years ago many in Europe feared the end of the world. Their survival joy created an exuberance and outburst of energy that made the next three centuries one of the most productive and progressive times in European history. It even triggered the construction of medieval MEPs: the grand cathedrals.

The popularity of astrology, TV psychics, and new age religions, suggests many are apprehensive about the year 2000. The planetary alignment of 5 May 2000 is already cited by some as evidence of the Earth's demise. Unlike the first two wildcards, it is obvious that millennialism does and will exist. If history is a guide, this factor could stimulate a societal zest for life that would ultimately allow humanity to claim its galactic heritage: the Moon, planets, and the stars.

## Conclusions

The main empirical result of this paper is the assemblage of historical evidence pointing to a clustering of events associated with important human explorations (plus MEPs and major wars) every 56 years near peaks in the Modus energy use cycle, over the last 200 years.

This result allows us to forecast that the decade from 2015 to 2025 will be the analog of the 1960s; i.e. it will involve major activities in technology, engineering, and human exploration. There is every reason to believe that the focus will be on large-scale human operations in space and that they will be *spectacular*.

One stunning example of a space MEP that could materialize around the early twenty-first-century Modis peak was suggested recently by the Speaker of the US House of Representatives, Newt Gingrich (a former history professor and space activist), who believes that 'space tourism

[45] *Op cit*, Ref. 2.
[46] Pinotti, R., ETI, SETI and today's public. *Space Policy*, **6**, 2 (1990) 161–7.
[47] Vallee, J., *Messengers of Deception*. And/Or Press, Berkeley, CA, 1979.

will be a common fact of life during the adulthood of children born this year, (and) that honeymoons in space will be the vogue by 2020.'[48] This vision is consistent with the historical trend of the last 200 years which reveals spectacular quantum leaps between successive Modis peak activities, starting with Lewis and Clark and culminating most recently with Apollo. In this spirit, NASA and the Space Transportation Association have recently begun assessing the prospects for tourism in Earth orbital hotels to become a multibillion dollar business.[49]

Early twenty-first-century space activities are also likely to feature significant international cooperation because of the large investments required and the fact that international relations are shifting. For example, Russia has an uncertain future and the USA is viewed by some as entering a period of economic decline,[50] while the Pacific Rim nations (especially Japan and China) may be ascending.[51] Increased parity among space-faring nations might trigger the formation of an international space agency in which the major space powers – USA, ESA, Japan, Russia – share power *equally* in the planning and management of major near-Earth space activities as well as those elsewhere in the solar system.[52] Acceptance of Russia in 1994 as a full partner in the International Space Station Program is an early step in this direction.

Twenty-first-century space planners should be reminded that the Modis Cycle falls as rapidly as it ascends, and that Modis peaks tend to be times of major wars. Thus if independence from Earth is not achieved by space settlers of the 2020s, large-scale human operations in space may be curtailed until the next Modis peak arrives in 2081! And without the proper use of space technologies and resources, it's likely humanity will have been engulfed or significantly altered by environmental-,[53] cosmic-,[54] or even computer-related[55] events.

The 56 year Modis and related technological, economic, and social cycles may be ultimately driven by a non-terrestrial stimulus such as the Sun. Even so, societal events are not predetermined by these ubiquitous waves as long as we actively include them in our planning.

[48]*Op cit*, Ref. 37.
[49]David, L., NASA begins space tourism enterprise assessment. *Space News*, **6**, 36 (1995).
[50]Luttwak, E.N., Is America on the way down? *Commentary*, **93**, 4 (1992)
[51]Kennedy, P., *The Rise and Fall of the Great Powers*. Vintage Books, New York, NY, 1987.
[52]Cordell, B., Interspace – design for an international space agency. *Space Policy*, **8**, 4 (1992).
[53]*Op cit*, Ref. 41.
[54]Gott, J.R. III, Implications of the Copernican principle for our future prospects. *Nature*, **363**, (1993) 315–19.
[55]McLaughlin, W.I., Human evolution in the age of the intelligent machine. *Interdisciplinary Science Reviews*, **8**, 4 (1983).