Practical space travel and unlimited growth

Source: http://sci.tech−archive.net/Archive/sci.space.policy/2008−03/msg00412.html

- *From*: Willie.Mookie@xxxxxxxxx
- *Date*: Sun, 23 Mar 2008 11:04:44 −0700 (PDT)

Any point on the Earth's surface may be be related to any other point in the universe by the minimum speed it takes to get there. The rate at which mass flows from any point to any other therefore is given by the momentum needed to maintain that flow. The cost of maintaining that flow is given by the cost of imparting that momentum.

Obviously then, the cost of momentum is an important measure of maintaining economic connections across the cosmos.

World shipping today is approximately 6.5 billion tons loaded each year. This is about 1 ton per year per person throughout the world. This was supported by approximately 1 billion deadweight tons of capacity spread among 4,000 ships.

3/4 of the total capacity consists of energy transport − oil, coal, natural gas. 1/4 container ships, finished goods, raw materials and food products.

Total cost of all shipments is around $10 per ton − or $0.25 per ton day aboard ships with an average time of shipping of 40 days.

http://www.unctad.org/en/docs/rmt2003_en.pdf

The United States on a per capita basis consumes 11 times this average.

The 9.5 million millionaires in the world consume 100 times this average.

So, this gives us a range of mass flows needed to sustain the Earth's population at today's per capita rates ($9,000 per year and 1 ton per year average), at US per capita rates ($60,000 per year and 12 tons per year average), and at millionaire per capita rates ($4,000,000 per year and 100 tons per year average) assuming various levels of productivity per capita. Raw materials account for approximately 20% of per capita costs worldwide, 10% of per capita costs to the average American, and 1% of per capita costs of the Average millionaire.

So we can see the value per ton is;

$9,000 x 0.20 = $1,800 /. 1 = $1,800 per ton
$60,000 x 0.10 = $6,000 / 12 = $500 per ton
$4,000,000 x 0.01 = $40,000 / 100 = $400 per ton

At $10 per ton shipping costs − we can see that all shipping quantities are profitable − obviously. We can also see there is a discount for larger volumes. Also, lower income levels consume more local supplies, and far fewer items from overseas, thus they tend to buy small quantities of luxury items. Wealthier nations and individuals tend to consume items from around the world as a matter of course, in their day to day patterns of consumption.

Also, 3/4 of the total relate to fuels. Obviously, beamed energy from solar sources in space to any user throughout the solar system obviates the need for fuels − excepting regenerative systems that are backups in the case of interruption of the beamed source.

The critical factor to unlimited growth is availability of resources in the quantities needed. 9.5 billion people consuming raw materials at a rate equal to the average millionaire today would consume 100,000 times as much raw material as is produced today. Clearly there is insufficient terrestrial supply for this huge demand. Obviously there are adequate supplies off world.

As noted 3/4 of the total shipping transports liquid gaseous and dry fuels. The balance transports everything else.

It is interesting to note that 1,000 ships each carrying 350,000 tons of useful payloads − operating throughout the solar system on the order of 3 weeks one way ship times, would carry all the non−fuel cargo of humanity today across the solar system. Most interesting is to compare the size of this shipping to the size of the larger Orion/ Rover spacecraft proposed by Stanislaw Ulam in 1947

http://en.wikipedia.org/wiki/Project_Orion_(nuclear_propulsion)

An all fusion pulse based unit using no fissionable materials at all, would permit opening the solar system to industrial development.

We can now look at what it takes to support a worker off−world. Based on material usage rates aboard the space shuttle, ISS, and nuclear submarines, it is estimated that 1 ton per year is needed to sustain a person off−world productively, and 100 kg (220 lbs) per year is needed to sustain a person off−world productively with a local water supply, and 10 kg per year is needed to sustain a tele−robotic operation, or a fully automated robotic operation assuming a humani−form robot.

Average per capita productivity ranges from $300,000 to $30,000,000 per person per year depending on the nature of the process and degree of mechanisation. The larger values are derived from a careful analysis of how mining and materials processing scale in zero gee.

Fully autonomous productive systems have been suggested in conjunction with space development. These are not yet available but are the subject of research. Should such systems prove to be possible increases productivity to arbitrarily high levels limited only by energy density and material availability. In this case, only the ability to transport the goods to users efficiently is the limiting factor. Yet, it should be understood that with nuclear pulse propulsion, the transport side of the equation HAS ALREADY BEEN RESOLVED − and arbitrarily adding an autonomous factory system needlessly delays developments that we already should be carrying out in order to maintain our leadership position in the world through providing important avenues of radical industrial growth while simultaneously easing our footprint on Planet Earth.

Laser pulse systems are also contenders that can replace the nuclear energy source altogether while achieving the same levels of performance or better.

http://www.niac.usra.edu/files/studies/final_report/527Kammash.pdf

The world today consumes energy at a rate of 15 trillion watts and produces roughly $60 trillion. To support the world's population at US per capita rates requires 165 trillion watts of productive capacity − with most of the increase due to personal ownership of automobiles. To support the world's population at the average millionaire level requires 16.5 quadrillion watts of productive capacity with most of the increase due to personal ownership of private jet aircraft.

Today's primary energy sources include principally;

the combustion of 28.3 billion barrels of oil each year
the combustion of 5.5 billion tons of coal each year
the combustion of 1.1 billion tons of natural gas each yeear

with the production of over 40 billion tons of carbon dioxide.

Using 100 trillion watts of solar sources covering 556,000 sq km of land to generate 3.34 billion tons of hydrogen gas each year by the electrolytic decomposition of 30 billion tons of water each year − these primary fuels may be replaced by off−world supplies.

Adding another 556,000 sq km of power satellite area in geosynchronous orbit, that illuminates the silicon based terrestrial solar panel arrays with solar powered free electron lasers operating at 37% overall efficiency − illuminating the silicon solar panels with 1,100 nm wavelength laser energy − at 500 watts per square meter on the ground − increases output to 278 trillion watts CONTINUOUS − allowing average per capita energy consumption to be more than DOUBLE today's

US per capita rate − and hydrogen production increases to 62 billion tons per year.

Using this as a base upon which to build additional energy capacity is provided by direct beamed energy from sun orbititing power sats, operating inside the orbit of Mercury, feeding energy to reforming satellites in medium Earth orbit − to drive automated personally owned ballistic transport aircraft − with laser powered propulsive skins.

http://en.wikipedia.org/wiki/Laser_propulsion

Since 1947 the United States has engaged in a policy to maintain security in the nuclear age by exercising the retail and banking functions to promote a large disparity of income between US citizens and the rest of the world. This income disparity has been used to maintain a global hegemony needed to maintain peace in the nuclear era, which is largely paid for by the bulk of humanity. Not by explicit taxes or war reparations, but through the natural operation of the market that tends to favor retail and banking functions.

Exploiting these market forces naturally gives rise to competing systems that undermine the strength of the systems the US relies on. Organizing banking and financial structures, such as the European Union, and organizing new marketing and branding structures, as the rise of German and Japanese marques, are a natural outcome. Furthermore, a large continuous disparity of income earned at the cost of others naturally gives rise to jealousies and attracts negative attention of extremists who view the United States as un deserving of its leading role since it contributes little except its special relationships that maintain its position.

A weakening currency, a weak banking system, massive debt, geopolitical weakeness, and outright attacks are all the long−term results of this course of action which were predicted at the outset as being long−term results of our policies. These were largely ignored since they were long−term. Responses were

a) the US would revert to 'direct military action' to maintain its position eventually and
b) the US would develop alternatives over the next 50 years (1947−97)

Neither of these responses were well thought−out, or pursued diligently. The US hasn't created and maintained a military force (assuming it could) to counter the entire world's negative attention and maintain its position, economic strength, and security in the process. Nor has the US invested in or developed any alternative to its exploitation of the retail and banking functions to maintain its position.

The first avenue is untenable. To maintain a state of war whether declared or not with the rest of the world, makes it impossible to trade with the rest of the world in a productive manner and maintain our existing markets in place. Furthermore, the cost of warfare cannot be moved to our trading partners if we are at war with them.

The second avenue is tenable, assuming that low−cost transport of energy and materials from off−world is possible. I have just shown what the requirements are.

For today's energy supplied from offworld, 556,000 sq km of terrestrial solar panels are needed.

For everyone to use energy at the US per capita rate, those same solar panels converted to laser receiver ground stations fed by 556,000 sq km of satellites in GEO is needed.

For everyone to consume energy at the average rate of all the millionaires alive today and additional 60,000 sq km of sun orbiting satellites in orbit around the sun inside the orbit of the planet Mercury is required, with laser reforming satellites in medium Earth orbit.

For raw materials, 6 billion tons, 72 billion tons, and 600 billion tons are needed each year withdrawn from principally the asteroid belt using laser propulsion systems − at a cost of $10 per ton.

At a 7% real growth rate from today's per capita rate − we're talking about $66 trillion today, $732 trillion to achieve US per capita incomes in 37 years, and $29.3 quadrillion to achieve $4 million per year − typical of the average millionaire today − in 90 years.

This is achieved by developing low cost solar panels, low cost solar panel powered free electron lasers in space, low cost beam steering technology, low cost laser propulsion systems, developing a fleet of 1,000 spacecraft capable of carrying 350,000 tons each payload, propelled by very powerful laser beams −

We start with a global wireless broadband, extended to interplanetary distances

http://en.wikipedia.org/wiki/Interplanetary_Internet
http://en.wikipedia.org/wiki/Teledesic

along with the development of terrestrial solar panel arrays producing hydrogen at very low cost −

http://www.usoal.com

augmenting fossil fuels. The hydrogen is used to replace coal in stationary applications, and to make low cost ammonia based fertilizer, as well as hydrogenate coal not burned in power plants. This converts the 5.5 billion tons of coal each year to 36 billion barrels of liquid fuels. Thus increasing the availability of oil from 28.3 billion barrels per year to 65 billion barrels per year − allowing a 230% increase in the global economy within 12 years at 7% per annum rate. Continued growth beyond this time frame will occur by expanding the production of hydrogen initially, and then, by direct beaming of energy to the majority of end users.

The United States will use the wireless broadband it developed to develop telerobotic systems that employ workers overseas in US based factories, managed by US workers. Products will be sold within the US and overseas.

http://en.wikipedia.org/wiki/Telerobotic
http://en.wikipedia.org/wiki/Asimo

Telerobotic systems will be used to extend the range of traditional mines, as well as to extend the output of mining systems off−shore and ultimately, off−world.

Large laser propelled spacecraft will be used to loft large power satellites into GEO and deploy them. Systems will be adapted to form deep space stages that deploy semi−automated systems to the asteroid belt. Deep space stages will also be used to deploy advanced powersats into solar orbit inside the orbit of the planet Mercury − increasing output 1,000s of times. A planetary power network will join the planetary communications network just described.

Rich asteroids and asteroidal fragments will find their way back to Earth orbit. There they will be joined by tele−operated factories that produce products on orbit. Orbiting pressure vessels will be created to process and assemble raw material extracted on orbit. As those pressure vessels fall in cost, farming and forestry will be added to the range of industrial products delivered directly to Earth from orbit.

Personally owned laser propelled ballistic transport will be developed and become widely available. Low cost pressure vessels manufactured in space from asteroidal feedstocks and teleoerated semi−automated factory systems on orbit − will create space homes. Large propulsion systems will be added to these pressure vessels, to allow them free access across the solar system. Ultimately, fully autonomous robotic systems working aboard large space colonies − personally owned − with adequate laser light sail and laser propulsion systems − powered from collections of power sats on orbit near the sun − will provide an interstellar capability for the human race − leading to what Robert Heinlein called − diaspora of the human race, and the beginning of true human civilization.

This is the way to proceed, and this is how America can lead the way.

.