III. Crash Program for Mars

First published in *EIR* on
October 21, 1988

Big Payback From Mars Colony Mission

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What follows is the first part of this 1988 article. Part 2 will be published in the next issue of EIR.

If the United States follows the approach I have proposed, we shall have our first permanent colony on Mars by the year A.D. 2027. During a few years following that, that colony will grow into an increasingly self-sustained community, the size of a medium-sized city on Earth. Long before A.D. 2027, the average U.S. taxpayer will have gained an enormous personal profit from the earlier, preparatory stages of the program as a whole.

Once the colony is operating, the benefits sent back to Earth will be many times greater than the cost of building and operating the colony; but, that profit will not come back as manufactured products, nor shipments of ores from the asteroid belt. There are presently no natives out there in the Solar System, waiting for the door-to-door salesman coming out from Earth.

This payback will come, even long before the colony on Mars is established. It will come, beginning the next 10 years, as increased income from the use of space technologies right here. Average income will be increased as a direct result of U.S. industrial, and other investments of new space technologies in production here on Earth. During the course of the first 10 years, the federal taxable portion of this increased average income could become larger than the government's annual space-budget. The space program's benefit to the average household and business should average four to five times the increased federal tax revenues generated.

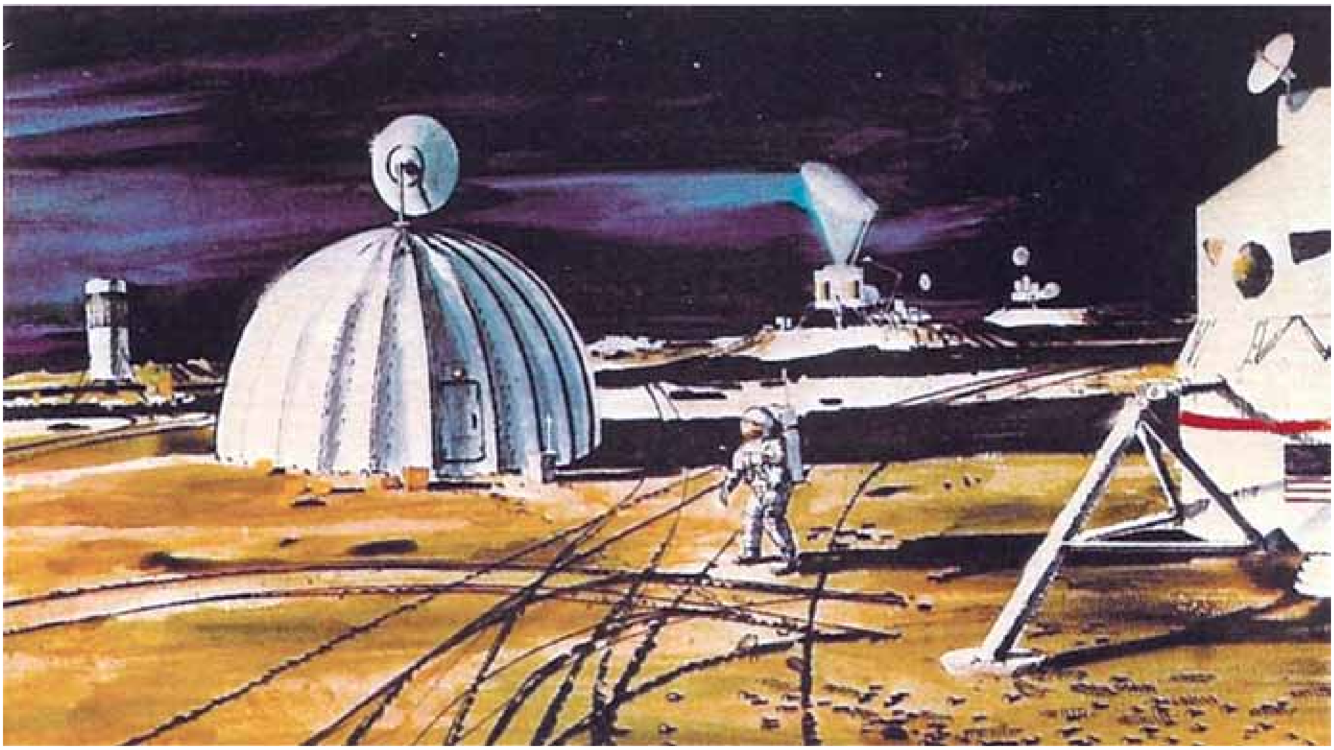
During the second and third decades, this profitable tax investment in spacedevelopment will grow to an enormous amount. Over the course of the first 10-odd years, average productivity in the United States should increase at the more modest rate, of between 3% and 5% per year. However, the rate of growth will climb, at ever faster rates, during the second, third, and fourth decades.

The following are only rough estimates, but our estimates are on the conservative side, and they are good enough for purposes of illustration. By the end of the 1990s, under this 40-year space program, the increases in operatives' productivity caused chiefly by industries' investments in use of space program-stimulated technology, should bring productivity to about 50% higher than today. By the year A.D. 2010, more than four times today's productivity. By the year 2020, 15 to 20 times today's productivity. By the scheduled year for establishing the permanent colony on Mars, operatives' productivity should average more than 40 times higher than the average productivity in the United States today.

We should stress the obvious fact, that all this will occur during the average working-life of the students who graduated during the year 1988.

Pipe-dream? Not at all; those estimates are cautiously conservative. We have allowed for much of the usual slippage, between what could have been achieved, and the delays and errors inherent to political, managerial, and other sources of lost opportunities. This report will indicate some of the facts which justify such an optimistic view of our nation's options for the future.

True, compared to our experience of the past 20-odd years, these may seem to be spectacular rates of growth. Yet, we have had periods in our national history, and periods in the economic history of other nations, during which more or less comparable rises in productivity have occurred, Reaching annual rates of 3-5% increase of operative's productivity, with 50% cumulative increases over a 10-year period, is a commonplace for vigorous economic recoveries. If the recovery is con-



NASA

Regular manned flight to Mars will require the industrialization of the Moon, to construct the space vehicles used to transport freight and persons to the Mars orbit. Here, an artist's conception of a manned base near the lunar South Pole. Power stations and processors are in the background, and the astronaut's landing capsule in the right foreground.

tinued through a second 10 years, with increasing rates of capital formation, the increase of productivity accelerates. So, our projections for the first 20 years are in line with lessons of past experience. If the nature of the technologies being used is considered, the estimates given are cautiously conservative.

Neither the federal budget, nor the U.S. Bureau of Labor Statistics sees space exploration as such. For them, "Space" is merely a statistical category in accounting procedures. Under "Space," the budget sees tax revenues spent, on the one side, and the increase of the nation's taxable income, on the other. Under "Space," the Bureau of Labor Statistics sees employment, incomes, and productivity in industries affected by the technologies developed for space exploration.

From the standpoint of Washington's federal statisticians, they see government funds going into the development of objects. To them, these objects have something to do with space exploration, but no revenue comes flowing into Earth from outer space as a result of shipping these objects up into orbit or beyond. In other words, we obtain no revenues from sales or the export of these objects to persons or companies in that foreign land called Outer Space. These are simply objects, which the federal government is spending considerable sums to develop and produce.

Lo, and behold! By investing in the development and production of these objects, U.S. employment and productivity are increased. Incomes of businesses and households increase. As a result of the increase of incomes, the government obtains its share as tax revenues at standard rates. After a while, the government is obtaining more tax revenue from the margin of increased national income generated by the investment in space technology than government is investing. In the meantime, total national income is increasing by a margin of expansion four to five times as great as the increase of federal tax receipts.

The Washington federal accountants' reaction to all this? "Who cares what happens to those objects once they are shipped out to space; this investment is the best money-maker in modern history." What Washington's groundling bureaucrat sees, is a large and growing research and development project, which more than pays for itself in terms of tax returns, and which is on the way to increasing average U.S. (real, physical) productivity about 10 times over the coming 20 years, and in sight of 10 times more than that during the second 20 years.

There is no hocus-pocus. It works, but there is nothing magical in the principles which cause this success. It is all very sound, and relatively very basic economic science. George Washington's U.S. Treasury Secretary, Alexander Hamilton, would have comprehended quickly, and would have nodded enthusiastic agreement. He would have pointed out to this writer that he, Hamilton, explained these principles for increasing the productive powers of labor in his December 1791 report to the Congress, *On the Subject of Manufactures*. So, if a bright fellow from 200 years ago could understand these principles, any intelligent fellow today could, too.

The politician who says, we can not afford a major space program, reminds us of the sly character who argues, "Look at the amount of money I'm saving on commuting costs," as an excuse to turn down a high-paid job, to take a low-paid, unskilled job, within walking-distance, at a nearby fast-food stand.

Why a Mars Colonization program? Would not some other project, closer to Earth, provide the same kind of economic stimulant? For the short run, there are several possible, large-scale research and development programs which would have somewhat similar effects. The difference is: The Mars project gives a higher rate of payback to the taxpayer, and over a much longer period of sustained economic growth, than any alternative in sight.

There are other, compelling motives and reasons for assigning priority to such a space program, We shall list some of these, turning first to the simplest, most easily understood of all of these motives, that of the ordinary citizen raising a family.

It Is Your Life, After All

What does the taxpayer gain from the U. S. government's decision to proceed with a 40-year space mission? His or her income is increased, of course; but, what are some of the deeper feelings the taxpayer ought to have when he or she thinks of the effect of this program on the future security and happiness of the family?

If "taxpayer" refers to the family household, family interest is centered around the future of the children and grandchildren. Why not be personal about the space program, in that way? It is your taxes the government must put up as investment. Apart from the pleasant fact that it increases your income level, what does such a 40-year project do for you, the taxpayer? How does it benefit your personal, family interest in the deepest, most personal ways?


wikipedia

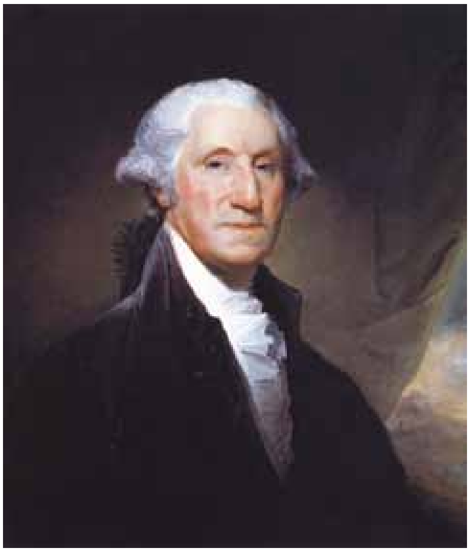
Alexander Hamilton

Once your children complete their education, we hope they have a life-expectancy, in good health, of about 60-odd years beyond graduation day. About 40 or more of those 60-odd years will be spent, either working for an income, or maintaining the home for the partner who does (a job in itself). As your children of today choose their educational preparation for a future working profession, those children and you, their parents, should make some rather important decisions.

Obviously, we must think of the need of every graduate to have opportunities for economic security during the coming half-century or so. There are some other, rather obvious questions to be asked.

On the subject of these other questions, the first thing which comes to mind is the fact that most of the adult life of an income earner is used up in the daily routine of work. The standard work-year now, is approximately 2,000 hours; if we allow a minimal average commuting time, and time out for lunch, typical employment uses up more than 50 hours a week, or about 2,500 hours a year. Times 40 years, that is 100,000 hours. Put the same facts another way: During the average 40 years of adult working-life, a person will expend not less than 45% of his or her waking hours on work plus commuting, often even more than 50%.

That makes a very persuasive argument for choosing the right kind of educational and related qualifications. We used to say, “Choose a life that amounts to something.” Forty-odd years later, shall we look back to say, “I spent half the waking hours of my adult life on something in which I take little pride?” Should we not hope that the days are ended, when work was viewed as a kind of punishment, a sacrifice made in order to have the price of bread? Individuals ought to have the right to enjoy work, to know that that for which they are spending half the waking hours of their working-adult life is something important to the society. A person has a right to the opportunity, to walk with pride, to say, “I am spending half my waking hours doing something which not only feeds my family, but which is so important for society around me, that I am entitled to respect for the importance of the kind of work I do.”


Portrait by Gilbert Stuart

George Washington

Parents and students have a right to ask, will the kind of career for which a student is becoming qualified continue to be a meaningful career opportunity, 10 or more years ahead? It is not pleasant to be told, “You have become obsolete; why don’t you try for a job washing dishes?” This involves economic security. It involves the right to have an opportunity to do something one can take pride in contributing to society.

Intelligent citizens who look a bit into their own and their family’s future in this way, can see the political side of this problem rather easily. The citizen, the family, the community, are, each by themselves, small and weak, when compared with the forces which determine the markets and the investment climate. Without the right form of government, and without the right governmental policies, there is no way the family can assure satisfactory conditions for itself over the coming 40-odd years.

Admittedly, under our federal Constitution, the economic functions of government are limited.

The Constitution gives the federal government authorities, duties, and responsibilities in the following key areas. U.S. currency and federal banking and other credit policies. Fiscal functions of government. Regulation of foreign and interstate commerce. Providing basic economic infrastructure including water management, production and distribution of power, general transportation, communications, and so on.

The federal government has a division of labor with state and local government, for providing such economically essential elements of infrastructure as education, and ensuring that both sanitation and an adequate health-delivery system exist. Government provides needed infrastructure either as an economic undertaking of federal, state, and local governments, or by fostering private investment in regulated public utilities, and by fostering regulated or self-regulated professional standards in these areas of basic economic infrastructure.

In other words, government’s economic functions are limited to matters in which private entrepreneurs can not meet the general need efficiently, unless they are very large-scale monopolies. Where we think the inefficiencies of government preferable to placing the nation at the mercy of giant monopolies, we rely upon the options of government undertakings, or federal or state regulation of privately owned public utilities.

Implicitly, our Constitution limits government’s undertakings to those we have indicated, and to the right of government to operate arsenals. The rest is left to private enterprise.

That American System of political-economy, established under George Washington’s administration, is the best economic system ever devised, with the best kind of division of labor between government and the private entrepreneur.

In this arrangement, the combined economic weight of monetary policy, government fiscal policy, and basic economic infrastructure are, combined, the largest single component of the national economy as a whole. In these combined areas, what government does, or fails to do when it should, is the largest single factor determining the health or sickness of the economy at large.

In addition to the raw power of government’s economic functions as a whole, there is another factor in which government plays a major role. This “other” occupies the largest part of our attention to economic factors in this report. The name of this other factor is "technology."

From the middle of the seventeenth century, in the Massachusetts Bay Colony, Americans have understood that the increase of the standard of living depends upon advances in average productive powers of labor. Until a change came in national policy, about 1966-72, we Americans understood, over the past 350 years, that advances in productivity occur as a result of a policy of investing in advances in technology. If we can maintain the flow of technological progress into production and infrastructure investments at relatively high rates, the average productivity and income of the population will grow accordingly.

The founding of the Massachusetts Bay Colony was led by the Winthrops and Mathers. Shown: the arrival of the Mayflower *at Massachusetts (1629).*

Government has no monopoly on technology. Scientific and technological progress begins as scientific discoveries by individual minds. Once the advances leave the laboratories, technology is developed chiefly in the machine-tool sector of the economy. For the most part, the machine-tool sector is made up of small private firms, in which most of the management is composed of scientists, engineers, and other very skilled and innovative technicians. Another important source of technological progress is the suggestion box of the enlightened manufacturing firm, which depends upon the voluntary ingenuity of industrial operatives working in their spare time as individuals or small teams. Then, there are those indispensable mavericks, the lonely, individual inventors.

Government's own economic roles in military and aero-space development, and in basic economic infrastructure, add to the total flow of technologies through the society as a whole. This is a rather important factor in determining the rate of technological progress generally. However, in terms of those kinds of concerns of the private citizen we described above, government has the responsibility of fostering technological progress in the society as a whole.

Government fosters private technological initiative, by building policies which encourage such private initiative, into its monetary, fiscal, and regulatory functions. For example, investment tax-credit policies have proven very effective. Job-creating investments in production which foster growth of employment, and increase the productivities and incomes of labor may find their profits taxed at slightly lower rates than profits which are not reinvested for such purposes. Credit should flow into technologically progressive investments at relatively cheap rates, and in relative abundance. Firms and households should be provided incentives to save, and to steer a goodly portion of those savings into equity and loans for such purposes.

In addition to these things, government plays a leading role, although not an exclusive one, of course, in the way our nation adopts a technological consensus. Some examples from our past history help to make this clearer.

Virginia's colonial governor Alexander Spotswood gave the nation its first major public postal service, a function taken over by Benjamin Franklin later. This was very important in the fostering of technology, among other benefits. Spotswood's program of building roads as a way of opening up large regions to development, was another feature of our early development. Government's responsibility for fostering a system of canals, and then the development of railways, are another example. Developing urban centers in such a way as to provide a desirable climate for certain kinds of technological investments, is another example.

Generally, if government makes a long-term commitment to fostering progress in development of certain technological improvements, and does this well, the economy as a whole is assured this is a field of investment and production which will be sound over the coming 20 or more years. Government says something like the following: "Here is a list of the kinds of technologies which are likely to dominate progress over the coming generation or two. Government is committed to using these technologies, wherever they are suitable, in its own economic functions, such as infrastructure. Government is building incentives for such investments into its monetary, fiscal, and regulatory policies, and commits itself to maintain these kinds of incentives over 20 or so years to come."

Therefore, the individual citizen is able to control the prospects for the family, in terms of opportunities for economic security, and career perspectives, for more than 20 years ahead. The citizens must work together politically, and in other ways, to ensure that the representatives they elect, and the policies demanded of those representatives, are consistent with that kind of longer-range security.

Alexander Spotswood

The Mars Colonization program is a very valuable, very large element of the kind of policy that the citizen's family will require for the kind of security it has a right to expect over the coming 40-odd years, Government must say to the citizens, in effect, "Here is the space program, and this is the way it provides your children the kind of economic and career-opportunity security they require over the coming 40-odd years," If the citizens agree to this choice, that must become the policy-commitment of government over the 40-odd years to come.

Through a properly functioning system of representative government, the individual citizen, otherwise too weak to control the vast and powerful forces of the economy as a whole, is able to steer government into choosing those kinds of long-range policy-commitments which ensure the opportunities for the children's future career and security over 50 years or more to come.

For such reasons, one of the first things citizens should ask of any political candidate, especially for federal office, is, "What is your policy for ensuring technological progress and career-opportunities for us and our children, over the coming 50 years?"

That said, we identify some of the most basic principles governing the way the Mars Colonization program will foster security and career opportunities over the coming 40-odd years.

Physical Economy

Before plunging into our explanation of the economic impact of the space program, we must clear up a handful of ABCs of economics. We must do so, because there is much confusion as to the meaning of that term. "Economics," in the sense the founders of our republic defined it, is no longer taught in our universities, and very few among those professionals called "economists" know the original meaning of the word. Most citizens are confused by what they read about it in the press, or hear from politicians, and from so-called "experts" on the TV screen.

Yet, almost any literate citizen can understand the ABCs of real economics, once the matter is explained slowly and patiently, by someone who knows. So, we must examine those features of that branch of economic science, "physical economy," which bear most directly on the way the Mars Colonization program will expand their family's income. Only those with appropriate qualifications in physics will understand all of it thoroughly, but all readers will be able to follow the general argument, the ABCs; they will get the gist of the rest, and that will be useful to them in following our description of the Mars program itself.

A hundred years ago, and earlier, "economics" was shorthand for "political-economy." Political-economy had two parts. One involved money and related things; that was the administrative side. The other was the study of the principles of physical economy, in which land, labor, and market-baskets of households' and entrepreneurs' goods were the area of concentration. "How may we best increase the fertility of land, increase the physical output of labor per capita, and increase also the standard of living?"

Physical economy as such takes up a large portion of the paper on economic doctrine of President George Washington's administration, Treasury Secretary Alexander Hamilton's December 1791 report to the U.S. Congress *On the Subject of Manufactures*. That is still a good textbook in economics, to the present day.

All of the calculations needed, to calculate the estimated impact of the space program upon the American standard of living, are made in terms of physical economy, without taking money calculations as such into account. Instead of money, we use standard market-baskets: Three market-baskets are needed. The first, obviously, is per capita household consumption's requirements; that market-basket must be improved as time passes. The second, also rather obviously, is the market-basket of entrepreneurs' goods required, per operative employed. The third, is the market-basket of basic economic infrastructure; this we measure both in per capita terms, and in units of land-area developed.

Although the development of a science of "physical economy" was well under way by the end of Leonardo da Vinci's life, it was established first as a true branch of physical science over the years 1672-1714 by Gottfried Leibniz. The eighteenth-century founders of the United States took their principles of physical economy from Leibniz, some directly, some indirectly.

Gottfried Leibniz

If the reader understands the ABCs of physical economy, the rest of political economy is no great intellectual challenge. Money and credit involves processes that are sometimes as complicated as governments, bankers, and accountants, and Harvard Business School can make them confusing, but not much more mental ability is required to understand the principles involved than one needs to plan today's family's household budget. All of the science in political economy, is locked up in the study of physical economy.

Leibniz's discoveries center around two topics. The first is the principle of the heat-powered machine. In this connection, Leibniz examined the relationship between increasing the amount of power supplied to a machine, and the resulting increase of the productivity of the operative. The second, is passed down to us as the term "technology," a term for which Leibniz supplied the original scientific meaning.

So, in the theory of machines and analogous kinds of investments, we distinguish two ways to increase the productivity of society. The first is to increase the effective amount of heat-power, or equivalent power, per machine (per operative). The second is to improve the principles of internal organization of the machine or analogous device; this is *technology*, or *technological progress*.

The simplest kind of illustration of what technology signifies, is sharpening the blade of a knife, or the point of a punch. So, a sharp knife cuts, when a dull knife does not. As these very simple examples suggest, the measurement of technology is a branch of geometry, the only way in which degrees of organization can be measured intelligibly.

Power and technology are not strictly two separate factors. There are lower and upper limits for the amount of power required per capita for any level of technology. Below that minimum level of power, the technology does not work. At the upper limit, to obtain further net gains, new, improved technologies are required.

The reason for the existence of these lower and upper limits is, that in production we are pitting the organization of the tools (technology), and the power behind them, against the organization of the material being worked. For example, let us imagine we have increased the average temperature (*energy-flux density*) of a process to a level above the critical temperature at which tungsten ore boils to form not only a gas, but turns that gas into a plasma. This would require us to work this plasma within magnetic confinement. By this, and associated changes in technology, we would achieve a major breakthrough in the kinds of things we could do. We would raise the heights of increased productivity we could achieve in many old and new branches of production.

That example is a real one. That is among the changes in technology we shall develop as part of the Mars Colonization project.

This reporter's professional specialization is the measurement of technology. Technology is measured in terms of what we call "negative entropy," or simply "negentropy." This is the only possible way in which to measure an increase in the level of organization of a process. Machines, or analogous designs of processes which have higher states of organization, by this standard of measurement, represent higher levels of technology than processes which are less "negentropic."

We must put in a few words of caution on the definition of "negentropy."

In physical economy, we do not measure "negentropy" as one finds in the usual undergraduate physics textbook. We use a different measurement, based, as we have noted, on geometry, rather than statistics. The kind of geometry we must use, especially for the case of modern technologies, is what is called the constructive geometry of the complex domain, as based chiefly on the work of two leading nineteenthcentury scientists, Karl Gauss and Bernhard Riemann. This geometric approach enables us to show a direct relationship between the increase of the level of technology represented as investments, and a resulting increase in the average productive powers of labor. That approach permits us to estimate with relatively great precision what the economic benefits of the Mars Colonization program will be.


Carl-Friedrich Gauss


Bernhard Riemann

The essence of physical economy is study of the ways in which increase of power and technology, combined, increases the average productivity of labor. Now that we have introduced the term "technology," we must define the other side of the equation, "productivity."

Instead of measuring productivity in terms of money income, our simplest unit of measure is what the leading nineteenth-century U.S. economists termed "economy of labor." For example, if so much labor is required to build a house or an automobile of a certain kind and quality today, how much labor will be required after 10 years of technological progress? The house should cost less to replace, but how much less? Good estimates can be made on the basis of calculating the "economy of labor" resulting from use of improved technologies. It is a bit more complicated than that, but that gives the general idea.

We measure this, as we said, in per capita unit-values of market-baskets. Using a standard market-basket for household consumption, for example, for the U.S. year 1968, what percentage of the total labor of society must be employed in producing enough to satisfy that unit-standard of market-basket for the average member of the household? If the amount of labor required to produce such a standard market-basket increases, that is bad; if it decreases, that is good.

However many hours of paid labor are required to buy the house you possess today, fewer hours should be required for a house of at least identical quality 10 years ahead. Fewer hours of paid labor should be required to provide each of the members of your family an improved diet 10 years from now, than today. And so on. That is the general idea of "economy of labor." That is a good crude sort of measure of the changes in the average productivity of a society over time.

So, when we foresee a 3-5% annual increase in productivity, not too far down the road ahead, that means a more than 3-5% increase in the "economy of labor."

This is not a matter of being generous for generosity's sake alone. In order that members of households entering the labor-force may be able to assimilate improved technologies efficiently, they require a higher cultural standard in the home and other aspects of personal life, including educational improvements. To increase the level of potential productivity significantly above 1968 U.S. standards, in later years, we require a better market-basket than we required in 1968.

Therefore, we could not base the measurement of productivity in 1998 on a 1968 standard market-basket.

In terms of quality and quantity, there must be more and better goods in the 1998 basket. So, over successive years, as technological progress increases the number of "widgets" per day produced by the average operative, part of that increase must be diverted into increased real wages. If not, the potential productivity of the operatives will not keep pace efficiently with future technological progress. So, instead of measuring physical productivity in terms of a number of standard physical objects produced per day, we must measure the number of daily average market-baskets of goods being produced, per operative per day. We must do this under conditions that the quality and quantity of goods in the standard market-basket are being increased as technology advances.

Therefore, there is a marginal statistical loss of gains in productivity, because of increased standard market-basket requirements. This margin of loss is not bad; it is necessary to keep economic growth under way.

There are many facets to this sort of study; but these have been covered in published writings. Here, we are limiting our attention to those matters which bear directly upon the impact of the Mars Colonization project. We now concentrate our attention on energy.

Rather than using the term "energy" in the customary sense, let us use the term "power." "Power" is a more complex magnitude than "energy" is used to signify generally today. In Leibniz's work, "power" (*Kraft*) signifies a quantity of what Leibniz defines as physical least action. "Physical least action" is the name for the way "power" must be defined for purposes of constructing mathematical functions of technological progress.

"Physical least action" signifies the maximum amount of work accomplished by a minimal quantity of action. This means "work" in the sense we use "work" in physics, not the everyday use of the word. We explain.

The idea of "physical least action" was discovered by Nicolaus of Cusa, as first reported in his *On Learned Ignorance*, and in other published writings and manuscripts. It arose out of the so-called "Maximum Minimum" principle, that the circle is the minimum circumference enclosing the relatively largest area, or that the sphere is the minimum surface enclosing the largest volume. This signifies that the area being generated by circular action is larger than the area generated by any other pathway of action.

From this came scientific studies which showed that the universe as a whole functions on the basis of such a principle of physical least action. The modern meaning of the term was established by Leibniz; it was on this basis that he discovered the proper definition of "technology." Least action, or power, is analogous to the action of generating the perimeter of a circle, or surface of a sphere; the net work accomplished, is analogous to the area or volume generated by that action. It is more complicated than that, but that is the germ of the idea.

This least action is expressed today in electromagnetic units of action, but the definition of electromagnetic is more complex than one finds in the standard physics undergraduate's textbook.

Power takes note of several qualities associated with what most people think of as "energy." This includes the simple quantity of electrical energy, for example, as measured in watts. It includes also the density of that energy, as, for example, how many watts per square centimeter of cross-section of the energy-flow flow onto the work-area considered (e.g., *energy-flux density*). We must measure the relative coherence of the energy-flux density, as we measure the purity of the radiation from a laser.

We must also take into account something most readers have not been exposed to in their earlier studies: the gain in work accomplished (e.g., per square centimeter or cubic centimeter) by what is termed a "nonlinear" form of electromagnetic pulse.

Nonlinear electromagnetic pulses are highly organized packets of power. For the layman, perhaps the most convenient mental image is that of a hologram. "Analytically," these packets look like holograms, although sometimes very complicated ones. They are more powerful than so-called linear electromagnetic radiation, such as sometimes by a factor of about 1,000, because they operate on the harmonic structure of living and nonliving processes, and this in ways which were wrongly predicted to be impossible in standard electrical-engineering textbooks.

These several aspects of power are a leading feature of many of the space technologies we are now in the process of creating in the laboratories. Future technologies on Earth will make more and more use of these principles.

Now, look at some practical examples of how these principles work together.

Energy-Density

Look back to about the year 1970, and compare some basic statistics for the economies of the U.S.A., West Germany, and Japan. We choose that year chiefly for two reasons. First, at that time, among the three nations, the levels of productivity of operatives and technology were approximately the same. Second, that is the point at which the productivity of the United States began to collapse. Compare the results with the cases of India and mainland China.

Look at **Table 1**. We have compared the economies listed in terms of 1) land-area of the nation, 2) size of the population, and 3) total energy-consumption, using standard official statistics. We have converted this data into the following derived statistics: 4) energy-density per hectare of land-area, 5) energy-density per capita, 6) population-density, in persons per hectare, and 7) energy-density per per-capita unit of population-density: watts per unit-per-capita area of population-density.

One point about the accuracy of the last data should be considered, so that no reader thinks we are misleading him.

Some readers would recognize, independently, that there is an obvious margin of error in the way the data in the last column is calculated: The calculation assumes that the land-areas of the respective nations are of comparable quality, on the average. There are differences in the quality of the land-area of the nations considered. Japan, for example, is composed of a high percentage of mountainous regions.

The refinement of studies along these lines, is the most basic feature of the day-to-day statistical work of physical economists. Refinements must include assorting the land-area among classes of land-use, such as farmland, pasture, forested areas, mountain areas, deserts, land-area consumed by transportation, and division of urban areas among sectors such as industrial, commercial, and residential.

Not only do we consider various classes of land-use, in that way. We must recognize that, although the type of land-use may be constant from location to location, the quality of the land used varies. It varies in natural quality; it varies as land is improved, has been spoiled, or has been allowed to deteriorate.

Obviously, we must study the population-densities of residence in each land-use area, and the weighted population-densities of operatives in the production to which that area is assigned. We must also adjust for the difference in quality of land-areas used; data not adjusted for this, we call measures of *population-density*; data which has been adjusted for functional differences in quality of land-areas, we call measures of *relative population-density*.

TABLE 1

Energy per Per-Capita Unit of Population-Density*

Year	Country	Teracalories
1970	United States	1.459 x 10^7
	Fed. Rep. Germany	1.625 x 10^6
	India	1.846 x 10^3
	Japan	1.352 x 10^6
	P.R.C.	2.974 x 10^3
1975	United States	1.442 x 10^7
	Fed. Rep. Germany	1.226 x 10^6
	India	2.322 x 10^3
	Japan	1.896 x 10^6
	P.R.C.	2.263 x 10^3

* Square root of energy per capita x energy per square kilometer

Such corrections would make Table 1 a large and complex one, and would prove little more than the point already nicely illustrated by that table in the form shown. It is obvious that the level of effective use of variations in technology varies according to energy-density per unit-per-capita value of *relative population-density*, but that this fact is illustrated by using the simpler data for average population-density.

Some subsidiary points of explanation to be made on that are as follows.

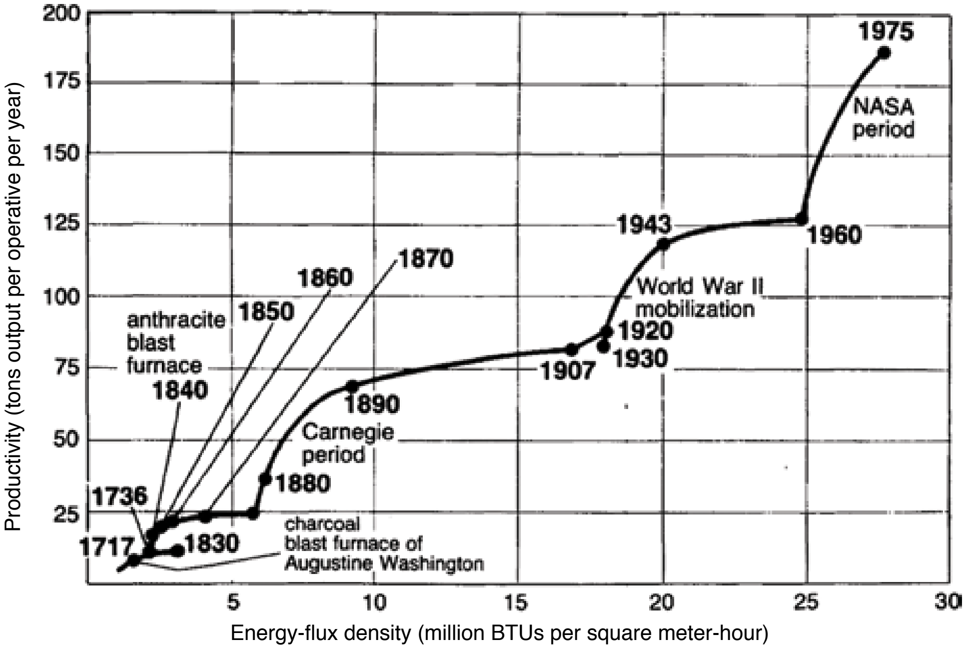
One of the leading reasons for some of the interesting features of the statistics on the three industrialized nations compared, is the role of basic economic infrastructure. This emphasizes water-management systems, general transportation infrastructure, the generation and distribution of power, and so on. In every industrialized nation, basic economic infrastructure is a major energy-consumer. So, the larger an area for which we must develop basic economic infrastructure per capita, the more energy that economy requires per capita.

Then, compare the cases of India and mainland China. With the very low energy-densities per per-capita unit of population-density, those nations could never reach anything near 1970 Japan levels of economic development. They might develop a few industrialized areas, almost to the level of competing with industrialized nations; but, the average output—the poverty—of the economy, the society as a whole, will remain at about the level indicated by the very low energy-density per per-capita unit of population-density.

That is the general idea of what we mean when we say that the level of energy-density is a "constraint." It signifies a condition which must be satisfied, in order to reach a certain level of effective use of improved technologies.

FIGURE 1

How Technology Elevated the Power of Labor in Blast Furnaces (1700-1975)



Energy-Flux Density

We have a second kind of energy-constraint to consider: This is usually identified today by the term *energy-flux density*. Look at **Figure 1**.

EIR researcher Robert Gallagher compiled data on the history of the iron and steel industry. He compared the energy-flux density of each successive general advance in iron and steel production, with the increase of productivity obtained by going to higher levels of *energy-flux density*. The case for iron and steel is true for every class of industry, and for agriculture, too.

To realize a given level of technology, not only must we have the necessary energy-density available, that power must be available at the required minimal level of energy-flux density.

The example to which we pointed earlier: The critical temperature (energy-flux density) at which tungsten becomes a plasma, falls into the same category as Figure 1's summary of the correlation between energy-flux density and productivity in the development of the iron and steel industry.

These two constraints are the key to design of the Mars Colonization project. They are key to the effect of those space technologies on productive investments here on Earth. By replacing energy with the appropriate, least-action definition of power, we are able to combine energy-density and energy-flux density constraints into a single constraint in terms of power.[1]

[End of Part 1.]

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[1] For the reader who insists on having the nature of this power-constraint identified, we summarize. The construction begins as follows. We define the physical space-time of electromagnetic action in terms of conical, rather than linear or simply cylindrical electromagnetic coordinates: electrical moment, magnetic moment, and frequency of each, respectively. The least-action character of each coordinate is expressed as the quality of coherence of frequency of isoperimetric, self-similar-spiral rotation in each coordinate. This situates electromagnetic least action in a constructive-geometric space corresponding to the complex domain of Riemann, et al. This implies the elaboration of the multiple connection among the three conical *self-similar-spiral action)* coordinates. Thus, the three-coordinate relationship is elaborated with respect to historical time.

Such a multiply-connected domain is characterized by the generation of increasing cumulative density of geometrically determined mathematical discontinuities (singularities). This generation is *harmonically ordered* within the Gauss-Riemann domain so constructed, in the same spirit that physical space-time is harmonically ordered in the work of Kepler. To this, an elaboration of Georg Cantor's most crucial theorem applies: the implicit enumerability of the increase of density of mathematical discontinuities per arbitrarily small interval of action of an axiomatically nonlinear form of continuing process.

Such an increase of density of singularities is a measure of negentropy, as we define it in physical economy. So, our definition of power is geometrically conformal with our definition of productivity (potential population-density). Thus, the causal correlation among the technological progress, power-constraints, and increases in productivity, is made susceptible of intelligible representation as a measurable relationship.