Energy Policy

### Arithmetic, Population and Energy, Part 1

Revision B, 2021

**For the love of the human race.**

### Our Thesis

We believe that Dr. Bartlett’s work is unfinished: it must be continued; the data base is always shifting, newer, creative solutions, which may not have been apparent a few years ago, when Dr. Bartlett did his primary investigations, need to be uncovered. The single human mind is always limited in its abilities: this work needs the contribution of every mind. New solutions must be found.

We have investigated Dr. Bartlett’s mathematics with rigor and found that his use of mathematics is both correct and precise. It is the task of the mathematician and the scientist to observe reality and explain exactly how and why it works. This field is known as mapping; Dr. Bartlett’s mapping speaks with deadly accuracy: he has been faithful in this task.[[1]](#footnote-1)

### Arithmetic, Population and Energy, Part 1

One expression of the basic exponential equation as used by Bartlett:

***y(t) = a \* bt***

Where, ***a***, is the value of ***y0***, the intercept where ***y(t)*** crosses the ***y*** axis, the initial value when the horizontal, or ***x*** value is zero; ***b***, is the exponential constant; and, ***t***, is the time, distance, or other factor plotted on the horizontal, or ***x*** axis.

***b = 1 + r***

The decimal rate of increase is ***r***: so if ***r*** is ***5%*** or ***0.05*** per unit time, then ***b*** would be ***1.05*** per unit time; if ***r*** is ***100%*** or ***1.00*** per unit time, then ***b*** would be ***2.00*** per unit time, in which case, ***y (t)*** would double every time a new ***t*** milestone is passed: but that milestone could be one square, one minute, one year, or fourteen years.

**“The greatest shortcoming of the human race is our inability to understand the Exponential Function.”**

The Exponential Function defines patterns of ordinary constant steady growth. In real life, growth is not a constant, but the math for variable exponential growth is presently formidable. We can accomplish all the necessary objectives by comparing a set of growth rate analyses against each other ***{1%, 2%, 3%, … 5%, … n%}***, or by limiting one growth rate to one range of values, then selecting a new growth rate for another range of values. In other words, by selecting a different map. Such sets of calculations will always give a precise picture of the situation. Or we can simply plot values on logarithmic graph paper, where steady growth will appear as a straight line, while variable growth will graph as a curve.

The real problem is finding accurate data. Data collection and reporting are often done fraudulently, lazily, and/or sloppily. This data, in particular, represents gigantic amounts of money, so it carries with it, powerful incentives and motivations on the part of all concerned to bend the facts, distort the truth, and take shortcuts.

**Doubling time, or 100% ordinary steady growth**.

If we begin with an initial value of ***a***, and a final value of ***2 \* a***, we find the doubling time:

***y(t) = a \* bt***

***2 \* a = a \* bt****: dividing both sides by* ***a***

***2 = bt****: taking the ln of both sides*

***ln (2) = ln (bt) = t \* ln (b)****: dividing both sides by* ***ln (b)***

***t (doubling time) ≡ ln (2) / ln (b****):*

Substituting values:

***t (doubling time) ≈ 0.693 // r/t = 69.3 // r%/t***

***t (doubling time) ≈ 70% // r%/t***

In developing this rule of thumb approximation, we make note of the fact that for ***r*** values of ***10%*** or less, the ***ln (1 + r) ≈ r***, and ***69.3% ≈ 70%***. The factor of ***100*** used in the lecture, simply converts a decimal to a percent. This rule of thumb makes it possible to calculate very accurate estimates in the head or on any handy scrap of paper. Just divide ***70*** by whatever ***%*** of growth is in mind. The following table compares the accuracy of the estimate to exact calculation.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Growth % per year / Growth time (years) | | | | |
| % / t | 1 | 2 | 3 | 4 | 5 |
| Exact | 69.66 | 35.00 | 23.45 | 17.67 | 14.21 |
| Estimate | 70 | 35 | 23.3 | 17.5 | 14 |
| % / t | 6 | 7 | 8 | 9 | 10 |
| Exact | 11.90 | 10.24 | 9.01 | 8.04 | 7.27 |
| Estimate | 11.7 | 10 | 8.8 | 7.8 | 7 |

These estimates are very good and usually err on the safe side.

In the chess board problem: we may number the squares from ***1*** to ***64***, or from ***0*** to ***63***. Since the Exponential Function always starts at ***t = 0***, we prefer including the idea of ***zero***. Dr. Bartlett starts counting at ***one***. Here are the equations for calculating the number of grains on any square, where ***b*** is ***200% per square*** and moving from square to square takes the place of time, and ***the doubling time is 1 square***.

***y (t) = 1 \* 2t = 2t***

***y (n) = 2n****: numbering from zero; or,*

***y (n) = 2n-1****: numbering from one: for example*

***y (63) = 263****: numbering from zero; or,*

***y (64) = 264-1****: numbering from one.*

The last square, whether it is called ***63*** or ***64***, contains about ***9.223 x 1018 grains***.

The chess board problem also considers accumulating the numbers as we go along. This sum is known as a geometric series and solving it involves a mathematical trick. Here it is:

***Σ = a + ab + ab2 + ab3 + … + abt****: multiplying by* ***b***

***b \* Σ = ab + ab2 + ab3 + … + abt + abt+1****: multiplying by* ***b***

We notice that the two equations are identical except for the first and the last terms: so, subtracting the first equation from the second equation we arrive at something we can always calculate quite easily.

***b \* Σ – Σ = abt+1 – a****: factoring*

***Σ \* (b – 1) = a \* (bt+1 – 1)****: dividing by* ***(b – 1)***

***Σ = a \* (bt+1 – 1) / (b – 1)***

In this case ***a = 1***, because we began with one grain, and ***b = 2***, because we’re doubling; so, at square ***63*** or ***64***, we have an accumulation of:

***Σ(63) = (b63+1 – 1)****: numbering from zero, or*

***Σ(64) = (b64–1+1 – 1)****: numbering from one.*

The accumulated grains amount to ***18.447 x 1018 grains***, which in mathematics is called a seriously large number, it is too big to understand, it is simply incomprehensible.

We make the observation based on an earlier square that the number of grains on one square is always one larger than that the accumulation of grains at the previous square. Counting from zero the doubling at square ***2*** is ***1*** larger than the accumulation at square ***1***; the doubling at square ***12*** is ***1*** larger than the accumulation at square ***11***. We see that doubling progresses at a formidably aggressive pace. The following proof only applies to this case, where ***a = 1***, and ***b = 2***. The general case is a little more complicated to prove.

***Σ(n) + 1 = y (n + 1)****: what we wish to prove; substituting*

***a \* (bn+1 – 1) / (b – 1) +1 = a \* bn+1****: substituting values*

***1 \* (2n+1 – 1) / (2 – 1) +1 = 1 \* 2n+1****: simplifying*

***(2n+1 – 1 +1 = 2n+1****: QED*

Dr. Bartlett’s use of mathematics is both correct and precise. Dr. Bartlett’s mapping speaks with deadly accuracy: he has been faithful in this task. This is exactly the way the exponential growth model behaves. The exponential growth model is, was, and continues to be the dominant social model chosen by our leadership. Current federal budget discussions[[2]](#footnote-2) are arguing the merits of a roughly ***2.5% growth plan*** and a ***4.5% growth plan***. Neither side is willing to discuss a ***zero or negative growth plan***. Moreover, the real facts are so clouded over by political obfuscation that it is often impossible to detect the unvarnished truth. The truth lies buried under multiple layers of varnish and wax.

**We should have paid closer attention to President Carter’s speech on energy in 1977. That was the last honest presidential appraisal of the energy crisis: we have been living in a state of denial ever since. Carter said “in each of these decades (the 1950’s and 1960’s) more oil was consumed than in all of mankind’s previous history.” That is a profound observation.**

### Our Conclusion

The principal point made by this part of Dr. Bartlett’s talk is that steady growth is in fact an aggressive, uncontrollable, vicious monstrosity that eventually destroys the culture in which it is allowed to exist. Growth must be restrained. If we are to take this “arithmetic” seriously, as we must; we must convince; nay, we must compel, we must demand that our leaders develop steady negative growth plans. If ***a 5% growth plan will double our consumption in fourteen years***, then ***a 5% reduction plan will halve our consumption in fourteen years***. The growth model must be put to death, before it puts us to death. Nobody can live with the 63rd/64th square.

We also ended up with a handy rule of thumb that converts difficult to understand growth percentages into easily understood doubling time.

***t (doubling time) ≡ ln (2) / ln (b****)*

***t (doubling time) ≈ 70% // r%/t***

1. Better results were achieved by playing the video clip directly from this site, rather than by linking through YouTube. Click on the arrow in the middle of the picture, rather than on the black bar at the top. This is Part 1. <http://www.albartlett.org/presentations/arithmetic_population_energy_video1.html> [↑](#footnote-ref-1)
2. Fall 2013 [↑](#footnote-ref-2)