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Competition and Cooperation: Human Power and Computer Power

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Abstract. The increasing amount of leisure resulting from growing computer power challenges society to discover how to bestow these gains to the whole population. Offsetting this human power still retains a comparative advantage in many areas especially the arts.
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1 Work and Leisure

Over the past 300 years there has been steady progress augmenting human power. Manual human work has been replaced by machine work. Mental human work is also a recipient of this progress. Drudgery in diverse forms done by humans is being replaced by tireless uncomplaining devices of all kinds. This began in weaving early in the 19th century with the invention of Jacquard's cards. The 1890 U.S. Census was the first application of this invention to process data. Punch cards and tabulating equipment now join the stage coach in the technology museum. By the beginning of the 21st century it is the most imaginative authors of science fiction who have become the best prophets of what lies ahead.

The numbers in the table illustrate my claim. These show a 50% decrease in the amount of time spent in the work force from the first to the third period spanning about 130 years. Period 4 gives my estimate of what is likely to happen in the next two decades. More time will be spent in schooling so people will enter the work force at an older age. They will leave the work force at a younger age thus spending less time as employees. They will have more time on week ends and on vacation. Therefore, leisure activities will become increasingly important thus continuing the trend for the past 100 years. Lowering not raising the age at retirement jibes with history.

Table

Period	-1-	-2-	-3-	-4-
Age entering Work Force	14	18	18	22
Age retiring Work Force	65	65	65	60
Weekly Hours	60	40	35	20
Vacation in Weeks	0	1	2	4
Total	159120	95880	82250	36480
Index	100.00	60.26	51.69	22.92

Suppose we accept the view that what happens must be desirable or it would not happen, the proposition of Leibniz derided by Voltaire. The trends show less time is spent in the work force but not at the cost of a reduced standard of living. Leisure must be a superior good for consumers who work less voluntarily. It also seems plausible that leisure is a complement to work because of what can be purchased with the proceeds of labor are needed for the enjoyment of leisure.

2 Who or What Thinks?

Even a concise summary of the development of mathematics establishes the limits of machine intelligence. The Greeks invented the standard approach to mathematics that took the form of definitions, axioms and theorems. Problems with this approach were soon recognized by Euclid himself on account of his controversial axiom about parallel lines. Xeno's paradoxes did not obtain a resolution until the invention of calculus by Newton and Leibniz more than a thousand years later. Indeed these paradoxes still beguile some. By the 19th century Euclid's doubts had inspired the invention of non Euclidean geometry. Galileo had discovered disturbing aspects of infinity when he demonstrated that certain subsets of all integers were as numerous as all the integers although less numerous in any finite segment. More than 200 years later Cantor proved that the real numbers could not be counted so they are more numerous than all the rational numbers. Gödel incorporated his method of proof to show that if the axioms of number theory are consistent, then there are true theorems that these axioms could neither prove nor disprove. On the basis of this result Turing could demonstrate there are

problems that no computer could solve.

Even in mathematical theory it became clear that human imagination and creativity are indispensable. While computers have a comparative advantage over humans in some areas, there are other areas in which the comparative advantage of humans is unchallenged and likely to remain so. This is true for the arts, literature and music. Computers free humans from drudgery and endow them with more freedom but will never replace da Vinci, Shakespeare, Mozart or even the lesser mortals.

3 Work and Leisure

Time spent at work is more accurately measured than what workers actually do at work. X arrives at work at a certain time, stays at work doing something or other and after the passage of a stipulated time departs from work. One could describe in detail everything X does during this working period. Similarly, we could do the same for somebody else, Y, who may or may not have the same job as X. The published statistics usually provide simple measures of time at work. Truck drivers, taxi drivers, surgeons, lawyers, waiters, plumbers, teachers and so on are all present in these statistics.

4 Logic

Logic derives from experience. It is evidently so because axioms are supposedly self-evident. The parallel axiom of Euclid since it refers to infinity cannot depend on any human experience and so it was called into question almost from birth. This axiom does not hold on the surface of a 3-dimensional globe. Research into the nature of the world starting with the discovery of magnetism in ancient times, observing static electricity, magnets, finding electric currents in rotating magnets and other experiments revealed new phenomena. It motivated some to propose new self-evident axioms especially in physics. These axioms win acceptance because humans are no more competent to explain these new phenomena than much earlier to explain why Socrates is a mortal who will die.

Hadamard' s essays on the psychology of mathematical invention are useful not only for mathematicians but also for anyone whose exposure

to mathematics was confined to high school or even to college courses for non mathematicians. It makes plausible the connection between, say, art and mathematics.

5 A Model Using Some Algebra

The model describes relations among pertinent variables in order to explore the effects of various views on work, leisure and computer power. The forms of the relations among the variables meet certain conditions. They assume a minimum amount of work is needed to produce consumption goods and computer power. Otherwise, neither could be produced by means of the assumed relations. The model says nothing about the motives underlying the relations. It makes no normative assumptions about the behavior of firms or households such as profit maximization or utility maximization.

Definitions. w=work, l=leisure, k=computer power, c=consumer commodities.

(1) $c = w^{\alpha} k^{\beta}$, α and $\beta > 0$.

The production of consumer goods is a concave function of the inputs of work and computer power if $\alpha+\beta \leq 1$. It is instructive to assume this. To assume $\gamma \& \delta > 0$, $\gamma+\delta \leq 1$ also leads to notable results.

(2) $k = w^{\gamma} k^{\delta}$.

It must not escape notice that computer power itself can produce compute power according to equation (2). This reflects the fact that computers are capable of self-learning and of reproducing themselves (v. Neumann, 1956). Dyson (2012) writes illuminating essays on this. Of course, as far as we know, so far Nature places an upper bound on the human activities, work and leisure. Equation (3) accepts this limit.

(3) $w + l = a$.

First, let us solve equation (2) for k as a function of w.

(4) $k = w^{\gamma/(1-\delta)}$.

Relation (4) would allow increasing returns to human power for the creation of computer power if and only if $\gamma/(1-\delta)>1$. But this would require that $\gamma+\delta>1$and concavity expressed by $\gamma+\delta\leq 1$ outlaws this.

However, $\gamma/(1-\delta)>\gamma$ if $1-\delta<1$ so that in this case computer power would have a comparative advantage over human power in making computer power. It follows from (4) that

(5) $w = k^{(1-\delta)/\gamma}$.

Substitute the expression (5) for w in (1) to obtain

(6) $c = k^{\alpha(1-\delta)/\gamma+\beta}$.

Equation (6) shows how computer power makes consumer goods. How big is the exponent in (6)?

(7) $\alpha(1-\delta)/\gamma + \beta$

Given that $(1-\delta)/\gamma < 1$ according to what was said before, it follows that computer power lowers the comparative advantage of human power in the production of consumer goods. This conclusion fortifies the verbal argument about the comparative advantage of computer power relative to human power in making consumer goods.

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