Cycle Depletion – a Worldwide Crisis[1]

Joseph M. Newcomer[2] and Charles B. Weinstock[3]

In 1982, the authors did not publish a paper they wrote on the then-obvious Cycle Depletion problem (CDP). Twenty-five years later, we are not publishing a twenty-five-year retrospective paper on this problem.

Sadly, the cycle depletion problem continues to worsen. There are predictions that we face the imminent danger of a cycle depletion crisis by the year 2020. This paper should serve as a warning to everyone that we must address the cycle depletion problem immediately or face the consequences.

In 1982 we had observed that the cycle depletion problem was already serious.

The cycle depletion problem arises because there are a finite number of cycles in the Universe, and computers are depleting these at a ferocious rate.

Computers suck down cycles and emit heat and computation. Without cycles there can be no computation. This is the fundamental principle that makes all our computers run. The number of cycles sucked down by any computer has been increasing (although we will see that there have been changes that have reduced the need for cycles by six orders of magnitude, thus allowing us to be in what appears to be a steady-state situation).

A result we should mention here was with the launch of the Cycle Isotropy Observatory (CIO) in 1992, it became clear that cycles are anisotropically distributed throughout the Universe, with heavy concentrations in some places and far less dense concentrations elsewhere. The current best cosmological theory is that our solar system, and for light years around us, is a cycle-poor region to start with, and therefore we are already at a disadvantage. Work by Hawking [Hawking99] show that cycle densities near black holes are incredibly high. Mathematically, the number of cycles available at the event horizon is infinite, but we simply have no technology to tap such cycles.

Ptolemy
(Wikipedia)

Cycle theory is nothing new. The earliest recorded work dates back to Ptolemy (150 A.D.) who postulated that the Universe consisted of cycles and epicycles. We now know that epicycles are not required, and cycles are all there are. But, like Democritus and his theory of atoms (460 B.C.) he was millennia ahead of his time. However, it wasn't

---

[1] Portions of this work were unknowingly funded by a grant from Tartan Laboratories, Inc.

[2] FlounderCruft, Inc. Email: newcomer@flounder.com
[3] Software Engineering Institoot

until modern Quantum Cycle Theory evolved that we began to truly understand the fundamentals of cycles in the Universe. As this theory has matured, it has led to the Schwinn postulate of Quantum Computers, in which all problems are either solved or not solved, and until you read the solution, you don't know if the problem is solved. (There is some question as to whether or not a Quantum Computer can solve the Halting Problem, and there is at least some fear that if such a problem were presented to a Quantum Computer, the computer would implode to a singularity and suck down all the cycles for hundreds of light years around. Others assert that this is the explanation of the Fermi Paradox: any sufficiently advanced technological culture eventually gets to the point where they try this experiment, and are immediately reduced to using slide rules, rendering them incapable of solving the kinds of problems that would lead to interstellar communication or faster-than-light travel). Quantum Cycle Theory also allows us to explain Cycle Anisotropy (CA), although there are some that say there is no possible way to explain CA

The current value of the Critical Density Ω_Λ is such that the Universe appears to be permanently expanding, meaning there is only one cycle (a so-called uni-cycle) to the Universe (there will be no Big Crunch followed by another Big Bang), so the dominant single metacycle means that all available cycles are merely subdivisions of this one cycle. Ultimately, a cycle may not be the atomic unit of computation, but the equivalent of quarks has not yet been determined. Nonetheless, there seems to be only one original cycle from which all others derive. This is one of the open questions of Quantum Cycle Theory.

A competing theory, derided by some as not being a theory at all, is that the one distinguished cycle is the source of all other cycles. Even within this theory there are competing points of view with some believing in the so-called Unicycle, and others in the so-called Tricycle – the latter having more adherents in the community. Regardless, both communities believe that the distinguished cycle designed and created all of the other cycles.

A theory of Vacuum Cycles suggests that cycles may spontaneously be created in the vacuum of space; however, they will be created with a corresponding anticycle and the two will cancel out according to the formula $e = MC^2$, but given that cycles may be massless, this means no energy would be produced. There is no good explanation of why our Universe favors cycles over anticycles.

We first observed the cycle depletion problem at CMU in 1976, when we moved our 16-processor multiprocessor, C.mmp, into the main computer room with our KL-10 processor. Shortly thereafter, the KL-10 began to experience various problems in reliability.

This led to one of those engineering-vs.-science debates. The engineers, lacking any solid theoretical basis, asserted that the cause was that the 16-processor system generated too much heat and overloaded the air conditioning system, raising the temperatures and causing failures. The scientists, on the other hand, with a firm grasp of cycle theory (even in its early form in those days), knew that the real problem was that the 16-processor system caused a local depletion in the time-space-cycle continuum, sucking cycles away from the single-processor KL-10 and causing it to fail.

In those heady days, it was believed the number of available cycles were unlimited, or at the very least good for centuries. There were few efforts to conserve cycles.

Early IBM mainframes were equipped with a “usage clock” that ran when the computer was computing. This measured the amount of usage of the computer, and hence the monthly rental cost. [We’re not making this up]. If the CPU issued a HALT or WAIT instruction, the CPU clock stopped running. While advertised as a way of reducing costs, it was clear that IBM was not creating cycles, and therefore (had cycle theory been known) was apparently charging for the use of a natural resource. But the opposing theory is that researchers at T.J. Watson Research Center had already discovered cycle theory, had grossly underestimated the available number of cycles (they had once been said to have stated that the time-space-cycle continuum could support no more than 12 computers), and had actually done this as a way of forcing their end users to conserve cycles by disguising it as saving money.

Those of us who “grew up” in the 1960s had an awareness of conservation that seems to have disappeared in the 1980s through the present. Many of us would work late into the night, sometimes overnight, to ensure that no cycles were wasted. Our more cynical colleagues said that we were doing this because we got better response time, but the real reason was that we could not bear to see cycles being wasted.

[Jack McCredie, faculty at the Carnegie Mellon University Computer Science Department at that time, observed wistfully at one CS party one evening in 1972, “Think of all those cycles going over the dam”. This was typical of the concerns we had at that time].

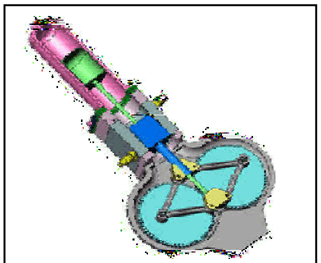
Harry Bovik did one of the fundamental experiments in disproving the *feng shui* theory of computing. This theory stated that the proper alignment of a computer with the cycle ether would result in more reliable behavior. In the Michaelson-Bovik experiment (unpublished), a computer was placed on a platform and operated for a period of time. The platform was then rotated 90º and operated for the same period of time. No change in the speed of computing or the reliability of the computer was measured (within experimental error), thus disproving the idea that cycles exist in the cycliferous ether.

Moore’s Law has saved us. As computers are built with smaller and smaller design rules, the actual number of cycles required has gone down as the same rate that the cycle speed has increased. A microcomputer uses microcycles (10^{-6} cycles), so a million computers executing microcycles consume about the same amount as a old mainframe executing cycles. Intel architectures, for example, do not execute instructions (in the CISC sense) but instead compile those instructions into micro-ops (μ-ops), and consequently we have been largely oblivious to the magnitude of the problem.

Federal standards for cycle conservation have not been well-enforced, particularly under the Bush administration, which fired all eight of the Federal Cycle Inspectors that had been hired by the Clinton administration and signed a contract with Dubai-based Hallibutron. Modern chips do have some of the cycle-saving mechanisms mandated by the Cycle Conservation Act of 1994 (a law largely spearheaded by Al Gore). These include mechanisms to slow the clock down under conditions of low usage, thus reducing the absolute cycle requirements; having sleep states and hibernation states that reduce cycle usage considerably. A public that is hungry for cycles would not accept these limitations for the sake of simple conservation (witness our treatment of the oil shortage issue), so these cycle-saving techniques are marketed as mechanisms for saving power (economic incentive) or extending battery life (self-interest incentive), but the truth is that they are there to attempt to reduce cycle usage.

Computer vendors continue to be afraid to let the truth be known about the upcoming cycle crisis. We already have evidence that IBM in the 1950s knew about this problem, and any vendor directly asked about this issue will deny it is a problem, while behind the scenes they work hard to deal with cycle conservation.

The increase in graphics requirements to support Symbolic User Virtualization, such as is used in video games, is another source of cycle depletion; graphics cards are simply very sophisticated domain-specific computers. There is serious concern about the impact of SUV popularity on our limited resources.



Stirling Engine (Wikipedia)

Since cycles are converted to heat, there are some thoughts that we should be able to have some way to convert heat to cycles. Unfortunately, the only effective state-of-the-art device we have is the Stirling Engine, which was invented in 1816. No more effective mechanism for converting heat to cycles has been devised. In principle, this engine can work at 80% of the theoretical Carnot efficiency, but it just doesn't produce enough cycles to make a difference. However, advances in nanotechnology could change this. Currently, nanotechnologists working on various kinds of mechanical effectors have not been able to understand the need for micro-Stirling engines.

Back in the 1960s, far-sighted pioneers such as J.C.R. Licklider saw the coming catastrophe, and created the ARPANet. One of the stated purposes of the ARPANet was to allow cycle-sharing, specifically, to allow users anywhere to share the computing on some non-colocated processor. This would allow them to place large computing facilities at the sites of major cycle concentrations, but users in cycle-poor areas could use these cycles.

NSF has funded a few supercomputer centers. Their apparent random distribution is not random at all; they are all located at sites of massive cycle concentrations.

Back when ILLIAC-IV was first installed, the original plan had been to install it at the University of Illinois campus. As an almost last-minute decision, the computer was located at the NASA Ames research facility at Moffet Field in California. The public reason given was that this was done because they were afraid that student antiwar activists might break into the computer room at the University and damage or destroy the computer. This story was simply for public consumption. Careful studies had shown that U. Ill. was in a cycle-poor region (no one who had chosen the original site was aware of cycle theory) whereas NASA Ames had been built (deliberately) in an area of high cycle availability.

Not all computer sites have been so fortunate. The Livermore Laboratories Supercomputer Center had been located at a cycle-rich site, but in later years, for reasons not yet fully understood (although Quantum Cycle Theory is beginning to yield some results) the nexus of cycles moved. This required either moving all of Livermore, or somehow creating more cycles, so a cyclotron was built there. Unfortunately, these are not cost-effective for everyday computing, costing tens of millions of dollars to construct and requiring military-grade budgets to keep running.

Not many people realize the true purpose of the World Wide Web. CERN suffered from the same problem as Livermore, and in their research to solve the cycle problem, the WWW emerged. Although the public cover story is that it makes information readily available, the real truth is that it is a network for importing cycles from cycle-rich countries to cycle-poor countries. The reason many emerging countries are spending such massive efforts on their network infrastructures is that they hope to become major cycle exporters in the next decade.

Not all emerging economies are in this state, however. The massive adoption of personal computing in India and China will soon mean that these countries will become major cycle importers as well. Neither of these countries are signatories to the Sapporo Accords (named after the beer drunk at the sushi restaurant where these accords were proposed), and the U.S. has stated that as long as these countries are not signatories, there is little that the U.S. can do internally to reduce its cycle consumption.

The real risk as that the cycle consumption in these countries will only exacerbate the growing cycle crisis, and competition for the remaining cycles from small but cycle-rich countries will result in serious international tensions. Estimates are that wars over cycles will be inevitable by 2030.

What can we do? We must reduce our cycle consumption. Estimates of 10% per year improvement will give us time to find alternative cycle sources, and there are promising research directions that may yield solutions in the future. Meanwhile, the use of slide rules and abacuses (abaci?) should be encouraged. PDAs should be replaced by calendar notebooks. Laptops should be reserved for holding cats, not computers. Besides, purring cats on one's laptop are far more soothing than computers, anyway.

References

[Hawking99] Hawking, Stephen, On the Diminishing Computer Reliability in the Presence of Universal Anamolies, *The Journal of Isotrophic Physics*, Vol. 17, No. 7, July 1999, pp1346-1378.