# The Story Behind My Publications

by Thomas Walker Lynch

## Preface

There used to be only three types of computing, that for business, scientific problems, and real time control. Machine learning and AI were theoretical pursuits. Probably due to Nvidia putting a SIMD machine on the market machine learning and AI have become their own area of computing. A fourth type of computing arrived unexpected, computing to facilitate social dynamics. We should probably add simulation as yet a fifth type.

With the goal of keeping my computer architecture proposals relevant, I have endeavored to at least be familiar with each of these types of computing. As an engineer and chip designer I have also studied design techniques and the physics of materials.

This essay provides a A '10 km high view' of my academic publications. For an alternative discussion of my awarded patents see,

> The Story Behind My IP

For a raw publication list of academic papers and patents see my Google Scholar profile.

> https://scholar.google.com/citations?hl=en&user=OEChA-UAAAAJ&view_op=list_works&sortby=pubdate

## Summary / Table of Contents

The entries in this table should be clickable links.

# Semantic Search

I was part of Dr. Andrea Cali's research group where we devised and implemented practical algorithms related to deep web search.

> Andrea Calı, Tommaso Di Noia, Thomas W Lynch, Azzurra Ragone, Processing SPARQL Queries on Deep Web Sources. 2018 https://dblp.uni-trier.de/rec/conf/sebd/CaliNLR18.html
>
> Andrea Cali, Thomas Walker Lynch, Davide Martinenghi, Riccardo Torlone, Processing Keyword Queries Under Access Limitations, Book Chapter, January, 2016. International Conference on Semantic Keyword Search on Structured Data Sources, September, 2015 https://link.springer.com/chapter/10.1007%2F978-3-319-27932-9_3
>
> Development was in Racket Lisp, code may be found here:
>
> https://github.com/Thomas-Walker-Lynch/liquid

This work inspired some thoughts on the representation of knowledge in memory.

> Thomas Walker Lynch, "Dataplex Database Morphology Allocation", 2015, https://www.researchgate.net/publication/331533214_Dataplex_Database_Morphology_Allocation
>
> The referenced code may be found here:
>
> https://github.com/Thomas-Walker-Lynch/liquid/tree/master/liquid-dataplex

# Computer Architecture

The following 65 page guide explains classical error analysis modified for floating-point algorithms. I wrote it to help Mitch Alsup analyze his soon to be patented fast transcendental algorithms.

> Thomas Walker Lynch, "Numerical Analysis of Computer Approximations," 2018, https://www.researchgate.net/publication/329402329_Numerical_Analysis_of_Computer_Approximations

The following 223 page book provides the theoretical grounding, and a bit of the implementation description, for a new computer architecture that I have been developing since the early 2000s.

> Thomas Walker Lynch, “Tom's Turing Complete Architecture", 2017 https://www.amazon.com/Toms-Turing-Complete-Architecture-Foundation-ebook/dp/B06VV7BLPY
>
> Here is code discussed in the book, written in SBCL:
>
> https://github.com/Thomas-Walker-Lynch/tm

At one point Brad McCredie at IBM said they would evaluate a cycle simulator for performance, with an eye on adopting the processor if it performed; however, he stipulated that I would have to raise enough investment to support a separate processor company which was proposing the model. If anyone wants to back a processor project, please contact me.

I’ve programmed some old machines. In 1978 Tom Lisco taught me to program the then 10 year old GE225. At about that time I also worked on PDP8, even repairing problems with peripherals. Later I studied computer architecture with Dr. Gonzales at UT Austin and I read about many machines. I have participated in the actual design of a number of machines, and have had the privilege of cycle stepping through many a boot loader. I read what one of McCarthy’s students wrote in answer to the following question, so when I was asked why the Lisp functions CAR and CDR were named as such, I open a manual for the IBM704 to point at the address register and data register on some RTL diagram. There were no such registers.

> Thomas W. Lynch, “Towards a Better Understanding of CAR, CDR, CADR and the Others”, 2015, https://arxiv.org/pdf/1507.05956

Dr. Cadogan had a hobby working on the Collatz Conjecture. He proposed to me that strings of ones would demonstrate convergence. So I responded playfully that such sequences would do the opposite, that they would cycle. Actually the paper ends with a question, I kind of wanted to know if anyone would notice.

> More Jabber about the Collatz Conjecture, 2011 https://arxiv.org/abs/1108.4056

Going back further, I do not have architecture publications about my startups after AMD, the 'organic K7', nor my telecom work. The K5 is covered in its own section. This brings us to the Am29050 adder.

It is unexpected to find a new adder configuration due to the maturity of the design topic, but I did. Through numerous requests for revisions, informative lessons on how academic papers were done, copious feedback from the Word grammar checker that did not like passive sentences, Dr. Swartzlander actually managed to coax from me these. Both are about the same adder. I still haven't figured out a good name for it.

> T. Lynch, E. Swartzlander, "The redundant cell adder", 1991, https://ieeexplore.ieee.org/document/145553/authors#authors
>
> T. Lynch, E. Swartzlander, "The spanning tree carry lookahead adder", 1992, https://ieeexplore.ieee.org/document/156535/authors#authors

The Arith conference was the first I had ever gone to. It was a wonderful experience. It was all thanks to Dr. Swartzlander. Maurice Wilkes was the keynote speaker and at the dinner table he told us a story about airborne radar in WWII. I don't think that is officially recognized even today.

However having a publication in computer arithmetic was an opening a pandora's box experience. The first deamon to fly out was Simon Knowles who publicly singled me out from the stage during the final discussion. "Thomas, how could you build such a big adder?" he asked. I really didn't know what to say. Frankly I did not know that was the case. Perhaps it was. Why bring it up then?

Simon made it up to me by inviting me along with some others to go 'punting', which was a relaxing respite for us passengers. There was some interesting discussion about *American culture* while Simon pushed us down the canal with a pole. I resolved to help the situation with communication between our cultures by bringing some people from his side of the pond to a project in the future if I had an opportunity, which I eventually did.

The 150 page 'Binary Adders' masters thesis followed. It surveyed what I suspect to be all published binary representation adder designs, their size and speed, and showed they are all variations on of a single fundamental operator. It turned out that the general carry skip adder optimization

problem is the fundamental associative tree / inverse tree design problem. A number of papers solved this optimization problem for specific cases. There was only one paper that claimed to have found a deterministic algorithm for the general case, but it used a discrete optimizer, and those have embed heuristics. 'Binary Adders' is the first to present a deterministic solution for the general case, and it even works when given arbitrary process parameters.

> Binary Adders, 1996,
> https://repositories.lib.utexas.edu/handle/2152/13960

The Conditional Sum adder used on the DEC Alpha eliminated the inverse carry tree computation; however, they did so while tripling the size of the forward carry tree. The Spanning Tree adder accomplishes the same but with very little additional logic in the forward tree. Due to this efficiency in size, it is also faster. The conceptual error and the reason so much of the logic in the Conditional Sum Adder is redundant is explained in detail in 'Binary Adders'.

A person might say that 'Binary Adders' was as successful as any study on adders could hope to be, yet according to Google Scholar there are still only four citations to it - and those four are all in Russian!

An IEEE Transactions on Computers submission arrived for to me for review. The article had been lifted from my work with only terminology changes. Relevant citations were conspicuously missing. I have good reason to believe this was intentional because the author was a boyfriend of my wife's and prior he had called me at AMD and threatened to shoot me. She had threatened to destroy me. The strange part is that other people in the arithmetic community seem to have weighed their options to profit from this, rather than repudiating it. There are too many stories to tell here, but a couple more are interesting enough.

I was at a conference when Dr. Milosc Ercegovac from UCLA and the conference organizer accosted me. Milosc had made a complaint that I was letting people call me "Doctor". A person at the conference had done so earlier, probably one of Milosc's students, and I had corrected him. I was not aware of it happening other than that, and explained as much to the

conference organizer. I also asked, “How many times do I have to correct such a thing before this becomes, not a question of titles, but an insult to me?” I don’t know what he was up to, but whatever it was I am pretty sure it was mean spirited.

Hopefully this is unrelated, but while waiting for a plane to California at Robert Muller Airport I ran into Dr. Swartzlander. During our conversation he told me that ‘Binary Adders’ should have been my PhD. He said that we had messed up the order my work had been done in. (Oh, and by the way, have a good flight ?)

Not so long ago, through an unrelated happenstance, I had a conversation with an author of the paper that had the discrete optimizer solution for carry skip. I don’t think he realized that I had reviewed his paper in ‘Binary Adders’ because he told me that he had solved the carry skip optimizer problem. Fortunately in ‘Binary Adders’ I had examined the very case he had presented as an example optimum. It was pure luck that he had chosen a case that the discrete solver heuristics had gotten wrong. ‘Binary Adders’ showed a more optimum solution. Gosh a lot of time has passed for that news not to have traveled, but on the other hand, no one is citing it.

My interest in Arithmetic goes beyond adders of course. That just happens to be topic that took on a life of its own. Kulisch and Miranker wrote an inspiring book that attempted to formally ground computer arithmetic. In the book they started by defining a ‘screen’ as a discrete space over which approximate computation would occur. I wondered if I could create a formalism for the end case substitutions Bill Kahan put in the IEEE 754.

> A formalization for computer arithmetic, 1991
> https://www.semanticscholar.org/paper/Computer-arithmetic-and-enclosure-methods-%3A-of-the-Atanassova-Simulation/e2d9e1ad4e234b58ed786228b3bac814828eea0a#extracted
> ISBN: 0444898344

That technique was generalized by a Bulgarian woman and presented at a Computers and Real Arithmetic conference. I will put the reference here when I find it.

# K5 Floating-point Nano Code

I had been at AMD for about ten years at the time of the K5. Before that I had worked on a robotics project in the fab, on a telecom processor, timing analysis on another processor, the Am486, the 29050, and the 29k. As Mike Johnson and Dave Witt brought the K5 architecture into focus I was told that everything was going to go through the super scalar machine, so it would be too expensive to add extra bits on buses. Dave told me that I would be "a hero" if I could still deliver accurate results, so I resolved to do so. I still had quite a while to think about the project, because the spec was still being written.

To get the accuracy I opted for a serial multiprecision arithmetic. I wondered if we could use floating-point digits. To see if this had a chance of working I wrote a divide algorithm. It was really peculiar in that the floating-point digits could walk to the right due to leading bit cancellation, or perhaps creep a little bit to the left. I formally proved that it worked, but without the intuition as to why the end cases worked out I was very nervous about it.

Every instruction we implemented was going to potentially have serial arithmetic and possibly have this same property of walking digits. It was clear that C++ and gnuplot were not sufficient for the development and early test environment, so I adopted Mathematica. Based on texts such as Hart and an experience on an earlier processor, it was clear that our only option was argument reduction followed by Chebychev minimax polynomials. It was straightforward, and Mathematica had a canned function for deriving the polynomials.

Traditionally in our industry this would be the end of the story. We would just take the arbitrary precision functions and run them in fixed precision, perhaps on expanded buses. During verification we would then make scatter plots of their accuracy. Indeed that is what Intel had done with the part we were competing with. I thought with the multiprecision approach that it would be possible to take things a step further and produced guaranteed accuracy out to the precision of the representation. In the worse case, if it didn't work, we could run the arbitrary precision algorithms like everyone else did.

I had made some good friends in the computer arithmetic courses at UT and saw this as an opportunity to give to them something that was very hard to come by, actual computer arithmetic design experience on a high volume commercial microprocessor. Mike Lowe said I could hire as many young folks as I wanted, so I worked and reworked my 'get the accuracy' project Gantt chart dependencies to make the project fit into one summer.

The plan was write a multiprecision library in Mathematica, recode the algorithms in Mathematica with a library of functions corresponding to K5 instructions, and then to compile the resulting Mathematica into u-op instructions of the K5.

So as to meet more candidates I started a monthly computer arithmetic meeting. I was a bit surprised when Dr. Swartzlander told his PhD students not to go, though I already knew them anyway. Debjit Sarma one of Dr. Matula's students came to the meetings and would later join AMD, but not on the K5. Also key was meeting Ken Albin who worked with the Boyer-Moore theorem prover, and those guys were at UT.

I first presented the multiprecision method, along with the approach for error analysis that I had originally planned to use, at a conference Jean-Michel Muller and Jean-Claude Bajard put together.

> Tom Lynch, "High Radix Online Arithmetic for Credible and Accurate General Purpose Computing"; Real Numbers and Computers... Les Nombre Reels et L'Ordinateur, Ecole des Mines de Saint-Etienne, France, 1995, 78-89.

As part of a class project, Swartzlander's student Mike Schulte and I created a compiler for the High Radix Online arithmetic with integer digits. It had High Radix Online as a data type, but it did not do the error analysis. We would publish this.

> Thomas Lynch, Michael J. Schulte, "A High Radix On-line Arithmetic for Credible and Accurate Computing", https://www.jucs.org/jucs_1_7/a_high_radix_on/Lynch_T.html
>
> Thomas Lynch and Michael. J. Schulte, "Software for High Radix On-line Arithmetic", https://link.springer.com/article/10.1007/BF02425915

For implementing the error analysis Bill Kahan suggested Robert Tisdale who was doing his PhD at UCLA. Robert did not look at my error analysis proposal. Nor did he want me to give him any directions on classical error analysis. He had done a masters thesis on the topic, and that is the approach he used. He sat in a cubical for a summer and ground it out. One manager even complained to me that he was literally living there while ordering in food and sleeping nights on the desk chair.

Swartzlander's student Tom Callaway wrote from scratch the production use Mathematica to nano-code compiler. It took in the Mathematica code, assigned registers to variables, and generated k5 u-op code. I just asked for the compiler, and then Callaway delivered it.

The conversation with Ken Albin then expanded to include J Moore. At AMD Chuck Colburn, Dave Reed, as well as myself were in favor of bringing this technology into AMD. Those guys managed to find the money so that I could have Moore and Matt Kaufman write a mechanical proof of the divide algorithm. This one instruction was so difficult, that doing the other instructions was out of the question.

> J Strother Moore, Thomas Walker Lynch, Matt Kaufmann, "A mechanically checked proof of the AMD5K86TM floating-point division program", https://ieeexplore.ieee.org/document/713311?arnumber=713311

I brought Mike Schulte in early, and the first task I asked him to work on was another proof for the divide code. I did not know at the time if for sure we would get the contract to do an automated proof, or even if we did if they could do it. I guess that Mike was rather unhappy to find that his divider proof was redundant, but really it wasn't. By the end he understood a great deal about the project. Mike then took Tisdales results and worked on writing the Chebyshev minimax functions using the K5 library functions, so Callaway could compile them. Mike understood every aspect of what we were doing. Mike and Ashraf would continue to work with Robert to get it right. Kelvin Goveas interfaced the nanocode engine to the rest of the K5. At the end of the day, we still had a processor project that was going through conventional verification so the edges of the work blended in with the rest of the K5 team. To commemorate the project we wrote this:

> T. Lynch, A. Ahmed, M. Schulte, T. Callaway, R. Tisdale, "The K5 Transcendental Functions", 1995, https://ieeexplore.ieee.org/abstract/document/465368

That summer was a wild ride. The outcome was superior. Fred Tydeman an expert in floating-point verification called the K5 the only trustworthy numerics in the industry.

The next project would not be so blessed. The DEC Alpha was not a commercial success, and when the company went under AMD brought in a lot of their design expertise, so we had a shake up also.

# Physics and Quantum Computing

The following white paper is about a project that began as a chess playing program, and then I noticed that the future potential move space had a lot in common with Schrödinger waves in QM. One of the nice things that fell out of this study was an interpretation of time as the crystallization of reality once a move is made.

https://www.researchgate.net/publication/317181287_The_White_Knight_is_Talking_Backwards_-_A_Bayesian_Hot_Gas_Crystallization_Model_for_QM

This project may continue in three directions from here. Its chess game may be improved. An attempt may be made to strengthen the correspondence between the Schrödinger equation and the Baysian field. Or, we may combine these two and call this a quantum computer. Of course, I am keen on working on this latter direction.

A friend pointed out that Ed Fredkin was going to be at the 'Physics of Computation' conference in Dallas, and that Ed had posited the theory that our universe was a simulation. I submitted a paper solely as an excuse to meet Mr. Fredkin. At the conference Mr. Fredkin explained, "When you walk into the NSA and see 5 stories of computers you just have to think all that has a purpose." I get his point. When thinking about what those computers are doing, they are in a sense simulating a universe. This was followed with something like, 'When you look out into space and see all those stars, it just seems they must have some purpose.' Hmm, and Stephan Wolfram would have us believe it is a big finite automata. Charles Babbage called it the *divine legislator* and then went on to invent the modern computer. The simulation hypothesis is indeed very old, and plays both ways.

The following paper gives the well known QM solution for a particle in a box. It notes that if we find any means for constraining a particle to a smaller volume that QM says we have to do the same work as would be derived by smashing with a piston. (An older physicist at the conference pointed that I really should include the time perturbation caused by the state change between larger and smaller volume.)

> Tom Lynch, "The Energy Content of Knowledge," Post Proceedings of the Physics of Computation Workshop, Dallas, Texas, IEEE Computer Society Press, 1992. https://www.researchgate.net/profile/Thomas-Lynch-2/publication/3708122_The_Energy_Content_Of_Knowledge/links/55b8aa4a08ae092e9658db14/The-Energy-Content-Of-Knowledge.pdf

While my wife was pregnant we were constantly running into each other when passing on the staircase or going through doorways because we did not compensate for the amazing continually expanding belly. A developing fetus is the universe inflation theory in miniature.

Now imagine a simpler example. Two helium bottles with balloons on top being filled. Now instead of a fixed ruler for measurement, use one of the balloons as the standard unit of length. Then animate the pictures while the balloons inflate. You will see two constant size balloons racing towards each other as though by some magical force of attraction. Yet no connections between them can be found.

In Einstein's mechanics, gravity is caused by time dilation. Here is an alternative model where an attractive force is caused by ubiquitous expansion. Perhaps the 'big bang' never ended, rather it is just everywhere. We are the big bang. Or perhaps the smallest particle in the universe is the universe itself, and it is expanding. Anyway, I made an animation and put it on my website. Difficulties arose for such things as one object in orbit around another. Perhaps someday I will get more time to work on it.

> Thomas W. Lynch, Expanding Mass Observed as an Attractive Force, 1997, http://www.thomaswlynch.com/grav.php

A friend posed a simple statistical question. I thought to make it complicated and have some fun with it. I think it might have applications to the interpretation of some QM experiment results, and am hoping to circle back to it someday.

> Coincidence and Premonition, 2012, revised 2017
> https://www.researchgate.net/publication/313011786_Coincidence_and_Premonition

A simple observation, as the earth gets warmer, fuel efficiency goes down,

> TW Lynch, Global Warming and the Carnot Cycle, 2009
> https://thomas-walker-lynch.com/essays/carnot%20and%20global%20warming.pdf

One of the things that appears to be missing from evolution theory is the possibility of perturbations to DNA being structured rather than anywhere point specific. Such a thing might be facilitated by horizontal gene transfer for example. Structured perturbation would bring the model of randomly driven mutations closer to what we observe.

> TW Lynch, Macro Sharing in Genetics causing Evolution, 1998
> https://thomas-walker-lynch.com/DNA.php

# Startups

I have founded and worked with a few startups. One of the more insightful things I learned about was scientific marketing. I wrote a short book about this, and Nikki edited it.

> Thomas Walker Lynch, "It Takes a Frontier Mentality: What Goes Into a High Tech Startup", 2016, https://www.amazon.com/Takes-Frontier-Mentality-What-Startup-ebook/dp/B01JD4WNLC

This is a lecture given in a big auditorium at NTU university. Note the video cited from the Wall Street Journal. It is a great example of what I mean by "Frontier Mentality".

> Thomas Walker Lynch, Culture for Innovation, 2013, https://www.slideshare.net/thomaslynch3979/a-culture-for-innovation

On a couple of occasions I have had the opportunity to present to investors my thoughts on how to perform better due diligence on startup business plans. The presentation must be pretty good because the Mustang Ventures lady plagiarized it without giving any credits.

> Thomas Walker Lynch, Thoughts on Due Diligence, 2013, http://www.slideshare.net/thomaslynch3979/thoughts-on-due-diligence-31884312

As part of my 21st Century Telephone startup I came up with a number of applications to be used with computer phones. I was trying to get to a place to combine the Internet with money. This white paper provides an interpretation for what money is.

> TW Lynch, Kryptonite, a Better Alternative to Gold For a Monetary Standard, 2010
> (TW Lynch, The Nature of Money, 2008)
> https://thomas-walker-lynch.com/money.php

# Computing for the Social Dynamic

Some of my most successful patents were early inventions related to social media. Those did not come from a vacuum. This essay in general, and this section covers some of my study of social dynamics and related publications.

Some of my favorite social dynamic pieces include Hemmingway's book about his writer colleagues in the 20s, "A Movable Feast"; Matt Taibbi's book about his journalism colleagues, "Hate Inc."; and Rachel Simmons's book, "Odd Girl Out – The Hidden Culture of Aggression in Girls". All describe environments with means spirited actors who used social weapons.

Aristotle noted that, "Man is a political animal." In "Sapiens" Harari says that gossip is what makes us social animals and that it plays an important role in decision making. Turchin and Nefedov in "Secular Cycles" provides evidence that intense social competition occurs in the phase before the collapse of a civilization. The movie 'Ridicule' captures this perfectly, https://www.imdb.com/title/tt0117477/.

The Milgram Experiment, and the Stanford Prison Experiment, show how social interactions translate into physical harm. Julian Jaynes goes so far as to suggest brain evolution is continuing. The following presentation suggests that it is not just the struggle against nature which has guided the evolution of homo sapiens, but also it is the struggle between homo sapiens themselves. We are making our own 'natural' forces.

> Thomas Walker Lynch, This Might Be Why, 2015 https://www.slideshare.net/thomaslynch3979

If correct, then social aggressors are truly intending to engage in a game that is so serious that it is driving evolution itself. It truly is about survival and definition of who we are, so it is no coincidence, for example, that a plagiarized paper is sent to a journal at the same time that the would be usurper threatens to shoot the actual author.

Here is a list of social aggression techniques.

> Tom Lynch, Components of Bullying, 2012
> https://avoiceformen.com/mens-rights/components-of-bullying/

Thomas W. Lynch, Techniques Used In Social Bullying, 2010
https://thomas-walker-lynch.com/social_aggression.php

It is interesting that a site for men's rights picked up the social bullying essay. Where as girls will probably be exposed to social aggression in the schools, as Simmons notes, the common working man might first be exposed to it in a divorce court. The suicide rates seem to confirm this. This game environment is perhaps the meanest of them all.

Tom Lynch, ITIO a Child, 2008
https://www.amazon.fr/dp/1435718267

Yuri Bezmenov said that a goal of KGB psy-ops was to get Americans to argue among themselves to such an extent as to be unable to solve their problems. It is probably no coincidence that this is the very description of Turchin and Nefedov's collapse phase. Indeed Russians trolls were found to be contributing to both sides of social media debates, not with the goal of making any points, but rather with the goal of teaching participants habits that made their arguments more intense and dysfunctional.

If dysfunctional habits can be taught, then we may also do the opposite, and guide people with good communication habits. This is the goal of my startup.

www.ReasoningTechnology.com

The other day I discovered an interesting thing about the 'Components of Bullying' link above. Facebook would not play it. In an effort to control forces such as KGB trolls, major corporations have unleashed AI algorithms that determine who can talk to who, and what may be said. This could potentially be the most power force we have ever seen, because it directly addresses the very thing that determines who we are as a species. I do have technology proposals for combating this. Contact me if you are interested in supporting that work.