Physicalness and mathematics

Do these relate?

This is the 3rd of a series.

- 1st – AI, not solely ML
- 2nd – Knowledge and truth
- 3rd – Physicalness and mathematics (see below)
- 4th – ML's emerge/surge and data/decisions
- 5th – Where do we go from here?

Foreword - Interim remarks

These are necessary after working on the first two pieces of the series which comes from the viewpoint of working in complex computational environments of a non-academic nature for five decades. "non-academic" is used merely to remove two attributes: paper chasing; overemphasis on generality (Note 1). The best example would be KBE applications in the industrial setting.

In the KBE setting in the commercial environment, we used and tested linear models such as those related to machine learning and multi-physics. As mentioned, this work initially was with the Boeing 777 project and continued across many of the other airplane programs as successes from the approach were apparent. As an outside (non-engineer), it was great to see all of the frameworks involved in action from the perspective of the commonality of mathematical modeling with computational assists. That experience developed into the initial definition of truth engineering and precipitated the true deep dive into our accumulated knowledge (Note 2)

Essentially, the drop of OpenAI's gift on our laps in November of 2022 did not get my attention. Why? For over two decades, my energies have been in surveying (in toto) the intellectual basis for modern views related to technology and its use, as the ubiquity of computational modes became more of a reality. The core issues relate to truth engineering, as defined, in the mid-1990s. Two images from a paper of that time are presented in this section.

Rather than at its entry into the world, I became aware of ChatGPT in late January of 2023 via a comment by a colleague who was remarking about reactions that people were having. Okay. I had to look and began research using resources from across the board, again. Too, I went back and reviewed notes from my experiences decades ago with xNN. Generally, I had agreed with Minsky's assessment.

A quick review showed me that the situation of a year ago was basically due to changes in abilities to compute; there had been no resolution of the deeper problems. Yet. Many were asking if we were closer to various goals that have been expressed over the year. I wrote several blog posts over the past year. One early reviewer said the thing was producing more fiction than fact. Reading about the math issues got me to give

Wolfram's system another look or two. He tied one xNN/LMM system with his. We'll go into that later.

Foreword – The past year

The world split into two camps: sayers and nay'ers. I am neither. It was obvious that there have been several oversights along the way, both in academia and in industry. Lots of topics were brought to the table and are still unresolved.

On the other hand, Bard of Google turned out to be a charm as it could be tuned into acting as a research compatriot. With it, I touched upon some of the core issues that deal with the lack of philosophical insights. These were apparent to me, let's say, with Kant as the pivot.

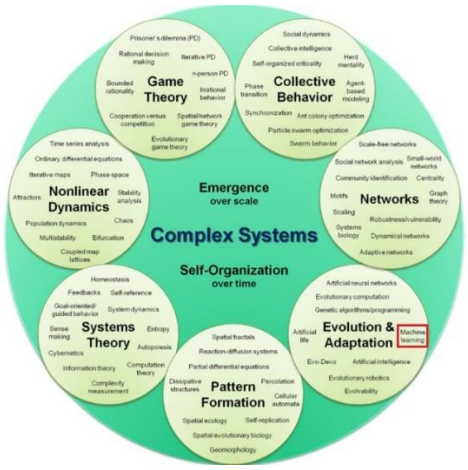
After a brief review, I touched bases with Larry Walker, the Director of the former Sperry Univac Knowledge Systems Center. We agreed that there had been some misstep. But, how did we go about addressing that? This series is one result. The first step was to get up to speed on the details. That did not take long. Most of the time was reviewing both sides as people lined up.

But I had done that anyway with regard to mathematics and its use in the various attempts by disciplines to lift their image. For example, "theoretical" is being used everywhere. But, at least, there is a common domain with which to address the diversity. Along that line, I am proposing that theoretical chemistry (rather than physics) ought to be the proper focus, a hint as to where to start looking.

What does that say for business? Well, it will be in the mix, too, as the commercial KBS/KBE is what Larry and I see as a rational basis with which to carry things forward. In the past year, I have relooked at KBE which is proof that AI did not have a winter. We will get to that, but see #2 for some links to those who have carried on the work.

Foreword – Complex systems and reality

We are dealing with complex systems. This piece will look at two topics, as listed below. However, we will have two others to cover before tying all of these pieces together: ML's emergence and surge; and data and decisions. Before listing the sections, here is an image that shows what we are dealing with. Notice, if you would, where "machine learning" is boxed as one aspect of a huge pile of intellectual information. Not to degrade the discipline as it will be important in the future, but ML cannot provide omniscience nor can it support omnipotence. Both of these are pertinent to the below sections.



Complex systems

The link in the caption of the image points to the original image. Naturally, there may be a desire on the part of the purveyors of ML to cover the bases. If so, this image covers that and more. Related to this is that the experience of success for KBE was that people were in the loop. In this case, they were highly trained engineers. And, the example that we will use is from decades ago as it demonstrates handling matters in a way that was obviously correct but was of the time. Lots of progress has been made since then. The initial basis needs to be better understood for KBE to be applied as it needs to be in the framework of artificial intelligence going forward.

Continuation of the series - #3

With respect to this and the next piece of the series, we will use graphics with some commentary that are meant to show some cohesion of the topics which might seem disparate. At the same time, these are full of significance since they illustrate the issues in a manner as one would expect with images.

So, the sections of this piece are:

- Physicalness – We mentioned using humans in the loop. What might that mean? In our context, we are talking engineers and digital twins. The former are humans with various computational “twins” that relate to attributes. We have to complete, nor even away to discuss, “twin” of a human. Nor, for that matter, for anything of matter that is other than fairly simple. Even then, it’s philosophically open to question about any claim of such. What is physicalness? Let’s see what might be a good way to discuss this.
- More on mathematics – This is our paramount, supposedly, attainment. From one view, that is so. There are many where it is not. That’s been my life work. Of course, to know details of this has required that mathematics be a common feature in my thinking. It has been, especially since the computer has progressed in its ability to handle the phenomenal aspects. For now, this section touches upon some subjects and points to reading material merely from an introductory sense. One might say that the philosophy of mathematics has been lacking. Or, if

it can be proven otherwise, how can the mathematics behind ML be lifted to general awareness so that people lose their sense of search for a “creature” of our making or which might emerge as a side-effect of our work?

Physicalness

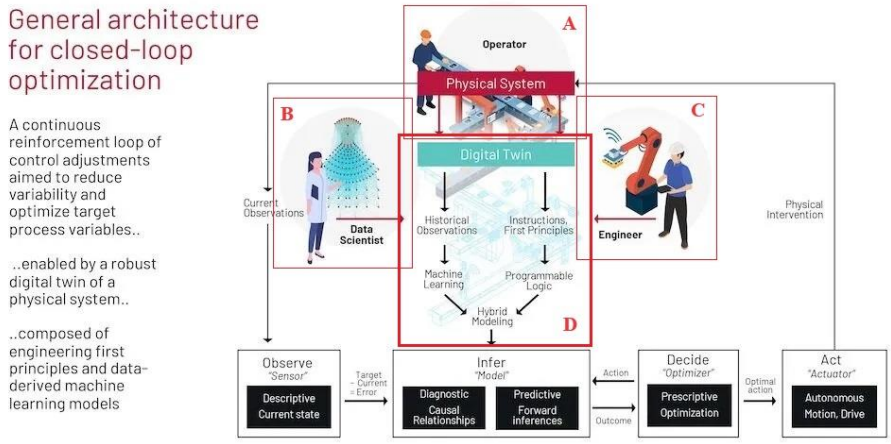
We, humans, are physical with obvious exterior limits. Of course, we do have components that neither we, nor anyone else, can touch. Say, what surgery goes after; but, let us put that aside for a bit. We, humans, also have made things. All along. Recently, we made the **BoBs** (buckets-of-bits – discussed in #2 but basically representing the current state of computing) through hard earned knowledge over time. We must not forget that long trek of seeking knowledge and dominion over our world. As we mentioned in #2, engineers, and their work, have been our principal means of change. After all, we are talking intelligence and other faculties that are important to our wonderful selves, being accumulatively purposeful through several generations.

BTW, applied philosophy? We humans are touching upon that. So, ignoring that for later discussion, let’s just pretend that **BoBs** cannot be intelligent nor can they have life and their output is not of the similar substance as we can do. We are not avoiding the subject. Our intent is to hone the arguments with respect to the current situation with the goal of reducing the influence of hype and increasing the truth processing (wherever it needs to be defined). And, we have already mentioned our interests in truth engineering.

As an aside, has the concept of “never” been brought forth in this series? We are talking now and the foreseeable future, for now. We will get further out later. Now, **Bobs** are specific configurations of matter, again, at this time, that use energy to give us illusions. But they are of different types, and work continues. Though, nothing indicates a remarkable change coming.

After all, **BoBs** can be tied to sensors and create new modes for science and engineering. At the same time, **BoBs** can run actuators and wow us (say, like the Boston Dynamics robots might have done for some). **BoBs** can be great imitators and can actually help. And, they have helped us in our efforts to resolve difficult problems. Again, is it not marvelous what clever people we are, engineers and all? BTW, engineers deal with the key issues that humans need to resolve a whole lot of problems.

In the following, we will use three images to continue the discussion.



What are the key benefits and strategies to implementing plant automation

This image comes from a periodical related to an industrial setting (Plant Engineering which has been in print since 1947). This section is titled “Physicalness” which we see represented by four things here: 1) the thing (**A**) that the operator is running; 2) that which supports the persons in **B** and **C**; 3) the three humans; 4) and that which provides all of the computational aspects (the real **BoB**s of hardware). The bulk of the physicalness besides the environment of Ma Nature’s stuff? The thing being run in **A**.

Notice, **D** has a label of “digital twin” (we called this **D** in # 2, for being the model of that which is twinned) as well as some boxes related to various virtual process flows. We liked this image as it shows the various players involved in the modern situation.

Aside: Workers used to have a stack of bosses on their shoulders from the local tyrant all the way up to the investor who owned the stock of the company and to the Board and C-suiters. Naturally, in the industrial setting various professionals were there, too. Now, there is the tyranny of the computational that we have to get a grip on. Oh, we know this? You bet. Truth engineering will influence “fairness” decisions in a way not seen yet.

Now, KBE was involved with this type of thing decades ago, as the next image illustrates (Note 3). The below is from 1994 but relates to work starting in the later part of the 1980s. It is figured that KBE goes back to 1986 (or before) in the CSAIL of MIT. But, we’re not talking precedence. Rather, our purpose is to detail provenance. a

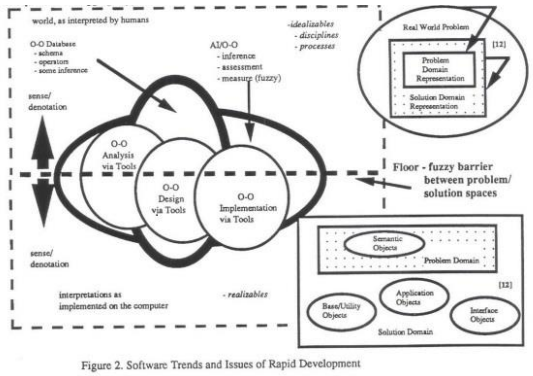


Figure 2. Software Trends and Issues of Rapid Development

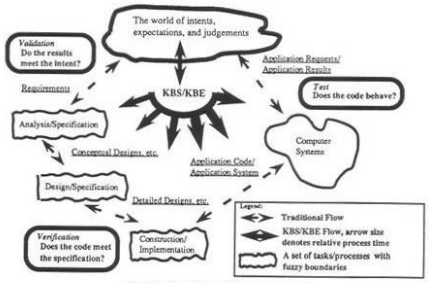


Figure 4. Verification, Validation, and Test

Mid-America Conference on Intelligent Systems (MACIS 1994)
"Applications in Manufacturing and Service Industries"
Oct. 27 & 28, 1994 – Marriott Hotel, Overland Park, Kansas

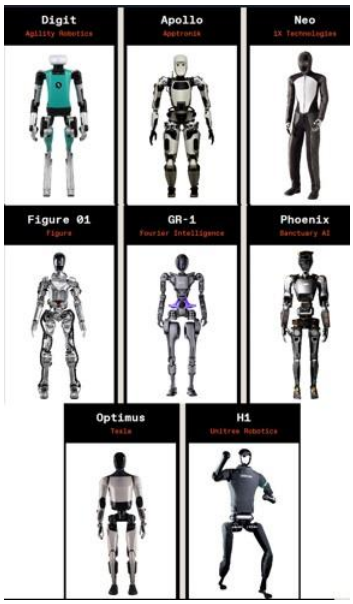
Practical issues of AI

In terms of modeling in the first image, most of the effort would be toward the apparatus being operated in **A**. But, would we think that there would be no other **D** involved? Not in reality, as by now, all of the positions/roles would have some twinning. And, the modeling would cover the shebang. But, our emphasis here is on the physical versus the imaginary stuff. The whole point of truth engineering is to get a proper grip on the issues involved with the growing complexity. "Product Lifecycle Management" is one overarching framework to discuss. There are others.

The second image deals with the modeling; it was done in the early stages of object-oriented approaches. ICAD/Lisp provided the software framework that can be discussed. Mainly, there will always be a division between the computational states and physical reality bridged over by side effects of various types. This is crucial point that is missed in a lot of what we see and results in the mania and phobia whose presence in human affairs was really brought to fore last year. But, we'll need psychological notions to address some of that. In the meantime, technology has given us help.

How? Robotics. These things used to be stationery and work on tasks that were performed by various types of training. There may have been some adaptive modes, but they were minimal.

So, autonomy was the answer. Yet, even there, the progress has been steady and slow. Not remarkable like the OpenAI drop of its pseudo-gift. IEEE has been following the progress and has a site devoted to surveying robotics and robots. The following image comes from their site (IEEE.org).



Humanoid Robots Are Getting to Work - IEEE Spectrum

The wish and, perhaps, goal? Intelligent, autonomous things that can do stuff including mimic humans in all of their glories and failings. Wait, that second one is not considered. Tsk. As, it is the important affair to science. So, the next section deals a little with mathematics as we need to pursue in order to have truth engineering at hand.

We talked about the “twin” of the virtual world and its non-physicalness. Robots, on the other hand, are very physical. Too, they bring in two major factors that we put into play as humans: sensing; acting. IEEE Spectrum says that 2024 will see the use of humanoids (see image). Okay, science and engineering work by thinking and doing. We can see the doing part, like the Boston Dynamics acrobatic robots.

Finess? Perhaps, we might see some of this. We, frankly, will declare this: lots of the decline of the quality of products is due to automation, even if it is not directly related to robotics (but, it can be). Okay? That’s a frank statement from decades of observation. Now, how can we address the issues? A deep look at mathematics will be the first step.

More on mathematics

How does one tackle mathematics? Is it solely a product of the clever of us? Or, is there some universal aspect that needs to be brought to attention?

Almost two hundred years ago, Galois, the brain behind group theory, mentioned “imaginaries” and such. It took the mainstream decades to understand his stuff after he died young in a duel. There have been lots of other controversial states through time regarding mathematics. Computation is bringing some of the more important controversies to fore.

Yet, we do see mathematics, largely, related to human talent. In the past few decades, we have seen computational mathematics being demonstrated. KBE was an example as a later piece of this series will describe. However, as with most human affairs, interpersonal relationships come into play. Some of this is due to separations that need further attention, a recent one being involved with what is computable or not.

Too, decisions? Are they top-down driven? Or, is there a framework for mathematics that would be uplifting in general to people and their lives?

You know, bullying methods have been one top-down characteristic that emerged to the extent of dreaming up the infamous mathematical machinery that has cowered many in the past two centuries. Case in point, there is a concept of almost-periodic that can be discussed various ways. It is used in a hugely complicated bit of mathematical reasoning that applies complex systems to obtain results that seem to work. Now "seem" alludes to the fact that the resolution of many of these issues require hugely expensive experiments and interpretations abound.

Can we do better? We very well may be on the verge of such; but **BoB**s and their roles will need to be defined a little differently.

Humans are the talented folks whose potentials have not really been understood, for many reasons. Our work, such as KBE, can address the whys and wherefores. But, notice that the "clouds" have been accompanied with very many types of busyness activities not dreamt of that is, perhaps, other than contributive.

SciFi (any media) is a type of dreaming; too, there are daydreams to consider. What we have seen is obvious in its non-physicalness. Of late, robotics has risen to the fore as possible savior. At least, the unknowns in that case deal with the specifics of the manifestation; as well, some of the economic factors might need more attention.

Constructive methods

KBE's domains were specifically related to requirements that were demonstrable and assessable. Other knowledge realms were similarly in having results that were touchable.

Normally, we have not applied strong relationships between physics (and the sciences it sustains) and psychics (Oxfordian usage from the 1850s) dealing with people. One complaint from those who ventured from the first to the second was that people are not like particles, meaning that the fancy mathematics does not work. Well, as one who started to do this six decades ago, some of the "fancy" stuff does work; ML is an example where optimization comes into play.

Too, it can be shown that the jury is out with respect to mathematics and its roles in both creating and providing the assessment means. One thing brought to bear with natural systems is that Ma Nature cannot be fooled.

Reminder: there is an adage in engineering that touts that teaching management a little mathematics results in water running uphill. Frankly, we might have been seeing a lot of

this later. For one, the mathematics of machine learning deal with more than what can be covered in a six-week bootcamp. Actually, even six years doubled would not allow sufficient time, even with herculean efforts.

A difference that we need to keep in mind is that science and engineering can go back to a “truth” source, almost always. In fact, success has come from applying that in the associated methods. Below, we address that further.

Before going further, “physicalness” deals with more than the small bits. We have cosmology and related, to boot. For now, consider this sufficient, as we continue with humans and their twins (again, digital and otherwise), the mathematics and thinking will more deal with larger issues. Economics split early into macro and micro fields. The former handles people in the larger sense of aggregate (mostly governmental in scope), or one might use a wider geographic views. The latter was the small view including people and their lives as well as companies.

How ought AI consider people? That’s one theme of this series. Briefly? We will attempt to show that “human in the loop” is more apropos, for many reasons, than most realize. In a sense, “unsupervised” is anathema to how we ought to work in a sustainable mode. Also, consider that people need to evolve some sense of computational interplay with their intuition.

Constructive mathematics

On mathematics, we have had eons of experience with changes coming hot and heavy over the past two centuries. This experience was driven by humans who had the appropriate talent and exposure to the proper facilities to do the work. Then, we had the computer come along.

Fortunately, prior work in constructive methods rose to the occasion, silently. KBE will bring this thrust more into focus. The Stanford Encyclopedia of Philosophy (Constructive Mathematics) has a very good overview of the topic. It recognized Brouwer’s contribution as well as brings in alternative views. Markov (the son) is mentioned, but we would like to bring in another reference to his work.

A coming topic deals with data which we have been working with for decades in the guise of tackling problems now referred to as data science. KBE was an early contributor to the field even with its natural focus, as computer modeling brings in the need for multidimensional work. What does that mean?

An example? The non-rational uniform b-spline (NURBS) is one approach to modeling curves and surfaces with commonalities brought to bear. The 4th of this series will look further into that topic. As a prelude and having mentioned Brouwer, we need to discuss the one thing missing which deals with the naturalness of this computational phenomenon that came to be. After all, matter is the basis. Hence the physicalness focus mentioned so far.

In this series, we are setting up for the necessary discussions. Humans love their ability to generalize which can be taken too far if we are not careful. What does that mean?

For one thing, humans need more attention in a mode not taken for several reasons. One of the reasons was lack of experience and data. Well, as we now see, data abounds. It's troublesome, actually, since most of it is mere recordings/reflections from lives being led without purpose. On the other hand, experiences of the past two decades need a review on many levels as what can become of purpose?

The computer phenomenon got out of control and became the playground of the immature as they used the rest of us for their experiments mostly done blindly since their underpinnings were wanting. Actually, this state of affairs was predictable. The signs and warnings have been there all along.

As I sit here writing, I am recalling my reactions to decisions being made that impacted the world all the way up to the current "clouded" affair. Are there benefits from the past two and one-half decades? Well, we can use almost two decades as it was in the 2005 timeframe when GSA of the US government said to go to the cloud.

How did that work out? One side-effect was for local and state organizations to work so as to put themselves and their clients in jeopardy. Wait, we're talking KBE as an example. Yes, we have also seen failures of many types that were not to be expected if things were done right. How do we know since cloaking became the norm?

These issues relate back to mathematics? Yes. That will be part of the coming dialog.

Coming topics, again

We are setting the stage to discuss associative links amongst the topics of the series. KBE is a framework for research in truth engineering as it is operationally demonstrative. We have two more topics to cover which are ML's emergence and surge (over the past decade) plus data and decisions (a core item but not the only one). The latter is related to demonstration with a patent as the initial focus (Note 4). But, to be mentioned everywhere will be KBE as an example of supporting talented, educated persons.

Context

Boeing Commercial Aircraft

Sperry Univac Knowledge Systems Center

Notes.

Endnotes.

1. Prior to my work experience, there was graduate work in mathematical and computational economics where the undergraduate work had been economics and mathematics in the College of Liberal arts and Sciences. Of prior interest was military experience in surgery (peace time) and a decade of jobs (white and not) performed in the economic milieu of the U.S. of the ‘60s and ‘70s. In that situation, the experience was full blown submersion across many domains and at all the levels that are involved in any major business climate. Other system uses included hands-on experience with (and development of) databases of all kinds. Part of the early work was large-scale statistics and operations research.
2. The concept of truth engineering came from computational work that dealt with the internals of the handling the requirements of solid modeling which has become ubiquitously present in modern analysis and design. “analysis” goes first as design is not done from a random start and means several things. But we are talking specifics of mathematical states that must be closed for operations to succeed. We were in a free-form surface environment and relied upon NURBS. This led to bringing in advanced concepts, such as manifolds. The work also handled filtering requirements in the pursuit of the smoothness required for downstream processes to be efficient. Naturally, this carried over to the experimental work related to alloy development where our algorithms out-performed the state-of-the-art, at the time. A patent describes the use of a lower order manifold to constrain one-dimensional streams of experimental measurements handled as points in time. The user could input expected properties of the manifold which allowed a sequence of decisions to converge to an optimal representation of a smooth curve with minimal error.
3. With the 777 project, Boeing emphasized design-build teams in which all interested parties were represented, especially the mechanics from the factory floor. Before this, in the industry, we saw over our years, lots of examples of dominance where some discipline threw their stuff to the next in line without any feedback mechanism. As things went down the line of silos, they became worse. Oh, yes. We will get to that. But, the 777 changed the game and turned out to be remarkable (still is). KBE was bolstered with that experience and has been going strong since.
4. Systems and methods for filtering and smoothing data, US7139674B2, Switlik and Klein