

Evolution of Civilization

Path of Engineering the Impossible to Possible

Faa-Ching Wang, Ph.D.
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Introduction

CIE/USA was founded in 1917 with a focus on science and engineering activities. For clarification of nomenclature, science is the discovery of new knowledge whether it can be useful or just for discovery of the next new knowledge. Engineering is problem solving. To solve a problem, a solution needs be designed, built, tested, and continuously debugged for repeated & sustained operation.

CIE/USA is 100 years old which is rare for a non-profit, volunteering organization. It is also a precious encountering for individual contributors who can be part of any centennial event in their lifetime.

For reference, the most renowned Institute of Electrical & Electronics Engineers (IEEE) was formed in 1963 and rooted back to 1884 for one of its' originating organization, the American Institute of Electrical Engineers (AIEE).

There is only a handful of Fortune 500 companies with more than 100 years history, to name a few, JPMorgan Chase & Co., Consolidated Edison, DuPont, GE, IBM, Ford, and Macy's. These enduring century club companies possess some common characteristics to stay true of their organization culture and traditions, maintain long-term relationship with their business partners and employees, contribute actively to the local community, and yet exhibit core competency to manage changes.

To a great extent, this is what CIE aimed to build.

CIE Evolution

There has being 3 missions, roughly one third of the century each, in CIE/USA history based on the authors' assessment.

In the early years of formation, the organization is simply to promote the engineering competency and bring awareness of the concept of engineering to the public.

Into mid-20th century, the organization mission has extended to support regional economic and industrial development, thus, the formation of the Modern Engineering and Technology Symposium (METS) with Taiwan in 1950s' and Sino-American Technology and Engineering Conference (SATEC) with China in 1980s'.

As engineering practice grew more commonality, the organization mission expanded further for the growth of the CIE foundation in US. DFW Area Chapter was formed under the circumstance in 1989.

With few historical missions accomplished and faced with drastically different environment today, the question is what would the next CIE mission be? To search for an answer, perhaps, history can provide some helpful hints.

Evolution of Civilization

A schematic illustration of the evolution of civilization is shown in Fig. 1. The X-axis is time and the origin is five thousand years ago. Y-axis is the level of accumulated knowledge. Although 100 years seems long, it is merely better than a snapshot when compared to the 5000 years' time span.

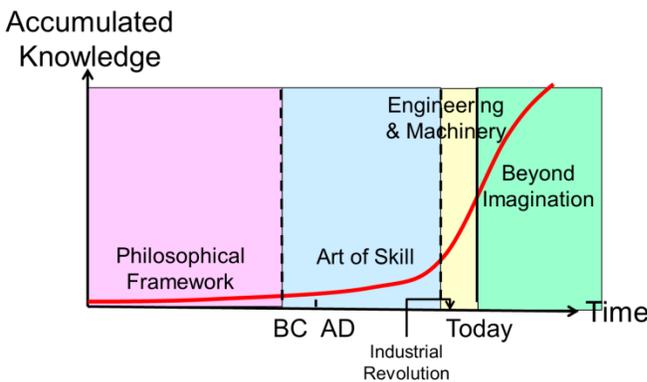


Fig. 1: Schematic illustration of evolution of civilization

Civilization developed gradually from the huge amounts of human learning efforts for a long time. It started in an empty box at the beginning and evolved to good frameworks of philosophies at ~ 5 century BC by the ancient philosophers such as Confusions of China and Aristotle of Greece; followed by the improved proficiency from the skilled craftsman of many kinds (music, painting, poet, dancing, hand crafts items, even martial arts, ..) at the next a couple of thousand years, but at small scale. Engineering competency and the use of machinery for large scale

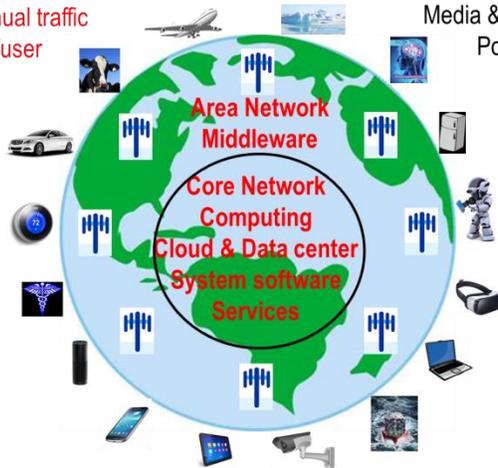
manufacturing finally become more mutual subsequent to the industrial revolution 17-1800 AD through the need of productivity improvement and repeated practice and failures.

The rate of knowledge accumulation further increased drastically in recent years.

Today's environment is the combination of massive acceleration of technologies that created the fusion between the physical, biological, and digit world with the complexity and speed never seen before in history. Industrial, academic, and governmental organizations in every part of the world are responding rapidly to the commercialization of data generation and data access, drawing on the wealth of data for adding knowledge and gaining insight into their operations. New applications in data analytics and learning, such as artificial intelligence, are being adopted by every profession, every industry and every aspects of daily living. New data center architectures and new network systems are springing up in response to the flood of data and demand for bandwidth with lower latency, as shown in Fig. 2 below.

It is estimated that 30-50 billion of user devices will be connected by 2020 or after. These devices equipped with the powerful ICs, sensors, and actuators gather data for applications to all vertical industrial segments, listed on the right side of fig. 2, generating several zettabytes (10^{21}) of date in few years which translate up to 10 GBPS bandwidth per subscriber at 1 ms latency, at least for the mission critical activities.

30B+ Connected devices
 Zettabyte annual traffic
 BW 10GBPS/user
 Latency 1 ms



Manufacturing & retailing
 Media & entertainment
 Politics & military
 Transportation
 Education
 Energy
 Health
 ...

The connectivity of the user-end devices to the core facility is through the distributed and low-power radio, wireless, or small cell area networks supported by the middleware such as FOG; where the core facility consists of knowledge-defined & self-aware communication networks, enhanced computing capability through optical, quantum, or DNA computation technologies, cloud and data center linked with AI, and system software such as SDN and security software platforms in order to provide various services to different user groups.

Fig. 2: Schematic illustration of a data generation system

This kind of system architecture and solution application as illustrated in Fig. 2 is something viewed as simply impossible even at several years ago and represent exciting and tremendous opportunities for scientific application and engineering problem solving.

Let's review a couple of examples next on how the civilization evolution has changed the things forever:

Case Example 1: Ground Transportation

In Fig. 3, an engineering case example of historical development of ground transportation is shown.

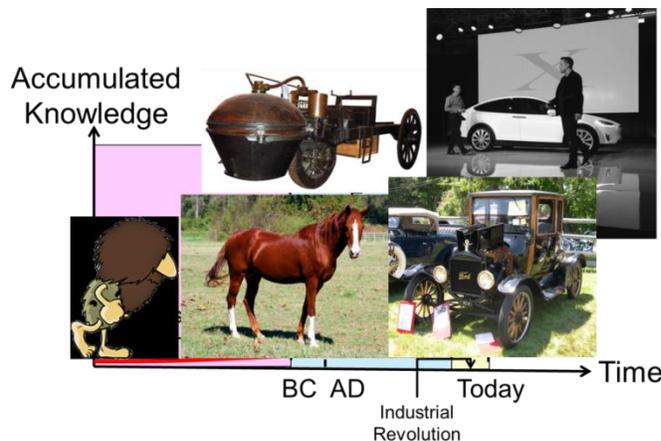


Fig. 3: Example of the evolution of ground transportation

For thousands of years, the two legs of ours are the primary tool for travelling.

Shortly after, horse, an animal of four legs, became the predominated method of getting around in the next 3-4000 years.

Until 1769, Nicolas-Joseph Cugnot was widely credited with building the first full-scale, self-propelled mechanical vehicle, a steam-powered tricycle.

But it was until Ford model T was introduced in 1908-1927 that car became the common device of transportation. Model T was named the most influential car of the 20th century in the 1999 Car of the Century competition. Ford's Model T was successful not only because it provided inexpensive transportation on a massive scale (16.5 million car sold), but also because the car signified innovation for the rising middle class and became a powerful symbol of America's age of modernization.

Then, it is for another century that Tesla introduced its model X EV in 2008. Tesla is another story of challenging the impossible by itself. Tesla Model X and S perform well with 2.7 sec acceleration to 60 mph (2 times faster than that of gasoline car), run for 200+ miles per charge with battery life exceed 8 years, and equipped with level 2-3 autonomous driving capability. Tesla has produced its first low cost revision EV, the model 3, on July 28, 2017 signaling the beginning of EV era. Only history will tell whether model 3 can be as successful to that of model T at 100 years apart.

There is not a good way to predict what the future transportation device will be. However, it is surely be something impossible in the past.

Case Example 2: Universal

In Fig. 4, a case of scientific discovery leading to better understanding of the universal is presented.

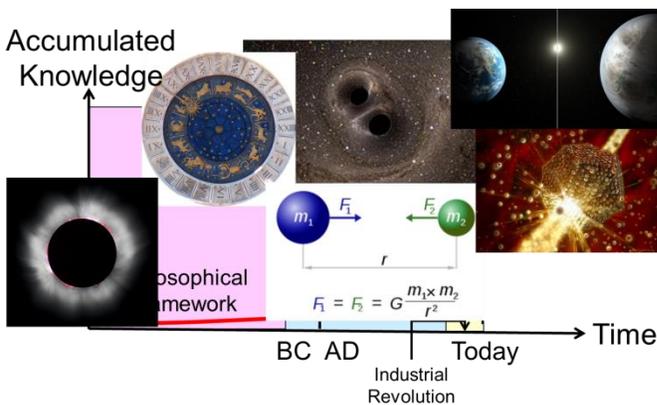


Fig. 4: Example the knowledge advancement on universal

While a massive crowd rushed to watch the nature wonder of the great American eclipse on August 21, 2017 (a century event since 1918), solar eclipse was viewed as a catastrophe from the anger of God in ancient times.

The study of Astrology has been dated back to 10 century BC by studying of the movements and relative positions of celestial objects as a means for divining information about human affairs and

terrestrial events.

Discovery of Gravity became one of the most important general Physics law published on July 5, 1687 by Isaac Newton. Gravity is a natural phenomenon by which all things with mass are brought toward one another with the force proportional to the product of their masses and inversely proportional to the square of the distance between them. This law was superseded later by the general theory of relativity published by Albert Einstein in 1915 providing a unified description of gravity as a geometric property of space and time. In particular, the curvature of space and time is directly related to the energy and momentum of whatever matter and radiation are present. In an extreme situation, black holes may exist in space in which space and time are distorted in such a way that nothing, not even light, can escape.

The science discovery continues in a fast pace into 21th century. NASA identified Kepler 22b in 2011, a planet with similar conditions to that of earth located 600 light years away and orbits 290 days around a sun-like star. In less than a month ago, Stanford researchers find evidence of the Majorana fermion, a particle that's its own antiparticle concludes one of the most intensive searches in fundamental physics in past 80 years, which may have significant future engineering application such as quantum computing. When Taiji was brought up as the "oneness before

duality” in 2 century BC, Zhuangzi, a Chinese philosopher, would not image that Taiji concept may, one day, be application to the fundamental unit of matter.

Future of Civilization

Thus, the future of civilization evolution is “*beyond imagination*”, shown as green section in Fig. 1, as human being is beyond thinking but actually engineering the impossible things of the past five thousand years. If history is looking back from thousands of years later, it is likely that this period of time can be viewed as the “*dawn of making the impossible to possible*”.

What a legacy would that be?

Adverse Effects

Are there adverse Impacts for what the civilization brought upon us? Yes.

Already, there were many victims of internet hacking. Professor Hawking further warned about the increase of threats to our survival from large scale disasters such as the genetically engineered viruses and new ways things can go wrong with the development of new technologies.

Future job and skill requirements will undoubtedly be different. A survey of National Bureau of Economic/American show ~25% labor force reduction in the job market since 2000, young male in particular, with increased interests in the virtue world and due to sluggish demand on the low end jobs.

Although not all tech companies like Uber, too many “Silicon Valley stars”, along with senior management and investors turned a blind eye to ethics due to rising stock’s valuation and rapid business expansion, said Vivek Wadhwa in his March 4, 2017 article on Washington Post.

What was discussed little is the obsolescence of the business processes and operation procedures, which Individuals and leaders have also fallen behind quickly.

Thus, when engineer delivers a solution, it must be a “*good*” solution including considerations of social framework and moral principles.

Future Outlook

As we move forward in a more complex and quickly changing world, CIE should turn its’ efforts to “*generation of engineering value*” for the entire humanity with short-term focus on the followings:

1. The organization need to stay on course of what it does the best, i.e. to continue improve its’ organization effectiveness, conduct leading-edge technical programs, create value to its sponsors, and nourish the young generation.

2. CIE should take aim in setting the course for an emerging generation of technologies and lead to success to the next journey with unprecedented opportunities and tasks in front of us.
3. We need new campaign on our social responsibility and to ensure the "*design-in of ethics*" when developing a solution, particularly, in today's environment of vastly skewed mindshare toward technology with analog to the organization campaign on engineering competency 100 years ago.

A full century ago, when the foundation of CIE/USA was first laid, the new civilization that had people talking was considered just as groundbreaking. Electricity led the charge of developments that were changing the way people lived every day from the first transatlantic radio transmissions to cellphone, from vacuum tubes to microprocessor.

The dawn of 2017 promises more amazing developments beyond imagination. Already, tourists can visit space, for a price, and medical science continues to test the boundaries of what makes us truly human.

As the world quickly grows more complex, leadership is to embrace new skills and new modes of thinking and to ensure that "*everyone at anywhere*" reaps the benefits of technological innovation and progress without the expense of others and environment.

CIE/USA is an engineering organization; engineer serves mankind by making dreams come true. CIE/USA has the knowledge, creativity, and competency to carry out its next mission. We welcome collaboration with other institutions and sponsors across industry that shared this common vision.

Human resources will become ever so scarce to that of financial resources in the fast coming and challenging environment. By providing the forum and networking environment, CIE serves as an aggregate of knowledge and practice ground to prepare our members and the young generation to become future scientific and engineering talents of need, thus, aligned to CIE/USA past, present, and future objectives, i.e. for networking and a forum for the wellbeing of all professionals.

Note:

1. This article is written for the centennial celebration event of the Dallas-Fort Worth Area Chapter of Chinese Institute of Engineers, USA (CIE/USA).
2. Dates of events in the article may vary based on the specific documents cited.