IT Curriculum Development in the Current Chaotic State of Technology

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IT, the 20\textsuperscript{th} century boon to the humanity is growing in its application almost in an exponential mode.

If one compares this development in any other field of Science & Technology since the last 4-5 centuries, there is no discipline which has spread its wings anywhere as far as IT & Computer Sciences.

Normal Growth of any technology from laboratory (R&D Stage) to industry adaptation (Maturity Level) to obsolescence was anywhere from 15-30 years or more. This duration from laboratory to obsolescence has sharply come down to almost less than 5 years. Sometimes Industry Captains declare a new technology (even half cooked) for competitive edge, within a year of the new technology.

This chaotic state of growth in this technology has been often explained through working together of three laws of Technology, namely,
1. Moore’s Law
2. Gilder’s Law

The convergence of these laws and general convergence of the technologies with IT working as catalytic agent has led the author to propose a 4\textsuperscript{th} Law. The importance of the same is discussed in the paper.

To keep with the symphony of the chaotic growth and to provide balance & counter balance serious thoughts need to be given for the development of curriculum.

A Student when graduates from a University/College is expected to take up job on cutting edge technology. But with the present rate of obsolescence, a student graduating with the static course could find himself ignorant of the current or developing state of IT technology. He could face a problem that most of the courses studied by him during the last 4 years are no more relevant. Thus he will find himself going into some other courses to meet the demands of Industry.

This paper describes strategies for curriculum development to cope up with the situation to minimize the agony of youth.
Dynamic Development Of Curriculum

IT, the 20th century boon to the humanity is growing in its application in an exponential mode. Today the IT & its tools have penetrated in every human activity. In 1940s, when computer systems were very expensive and of giant structure, the researchers and scientists would consider them only for mission made limited application. Even when IBM brought PCs in the market or Bill Gates wrote MS-DOS for them, One is not aware that anyone at that time could safely predict the explosive acceptability of these system for day to day application.

Gordon Moore when in April, 1965 wrote an article predicting the doubling of complexity of ICs in 18 months might have considered the application and growth for limited time span, but technologist and engineers have made the prediction true or technology follow Moore’s Law till now and there are all reasons to believe that the law may prevail for another decade or so. Besides the increase in the complexity and processing power the size is shrinking and price is sharply decreasing, making the system affordable and easily transportable. Experts believe sooner then later each home, may, even an individual person may carry a few tens to hundreds of embedded chips well connected with each other as well as with the Internet, just like the neurons in the human body.

The rapid expansion of bandwidth and fast improvement in connectivity are governed by Gilder & Metcalf’s Law respectively. All these developments have led to technological convergence and multidisciplinary research & applications. This is positive aspect, but this has also led to chaotic growth, fast obsolescence and cut throat competition for sustainence. To safeguard against that we have proposed; i) a 4th law of technology & ii) a strategy for dynamic development of curriculum to enable the youth entering industry to face this chaotic growth.

This paper is divided in 6 sections. The present section on introduction is Section 1, Section 2 briefly describes the three laws of technology and their impact on decision making. Section 3 describes the technology convergence and chaotic growth leading to certain concentration based on attractors or thrust areas of human needs. Next Section 4 describes 4th law and its significance. Section 5 gives the philosophy of dynamic curriculum development. And the last section 6 summarizes the conclusions of the study.

2. Three Laws of Technology

The 3 laws of technology in the present era are related to the exponential growth of processing power of computing, bandwidth for exchange of information and total connectivity making the planet of our accessible anytime anywhere. These laws are

1. Moore’s Law
2. Gilder’s Law
3. Metcalf’s Law

These laws and their implications are briefly described below.
2.1 Moore’s Law. This law was enunciated by Gordon Moore Co-founder of Intel USA in the year 1965 through an article published in an ‘electronic magazine’, where in he described various possible trends in the increase in complexity of chip. He had given various observations based on the developments between 1959 to 1965 and projected it further in a general formulation, which has now taken the form of law. This is generally stated as,”The complexity(or number of transistors) doubles every 2 years (Sometimes taken as 18 months), the size thus becomes smaller and smaller, processing power doubles and price decreases for a given level of computing by 40-50%”.

These aspects are also depicted in fig 2a&2b. Surprisingly this prediction is coming true and may continue for another decade or so. But when the size shrinks to the molecular size one would be confronted by different laws and the computers may be far different than conventional computers we are accustomed to work today.

**MOORE’S LAW IN OPERATION**

DENSITY OF TRANSISTERS IN ICs WILL DOUBLE AT REGULAR INTERVALS OF ` 2YEARS ACTUAL 18 MONTHS.

![Figure. 2(a)](image-url)
2.2 Gilder’s Law

George Gilder in his book ‘Telecosm’ formulated the 2\textsuperscript{nd} Law, which states that “The total bandwidth of communication systems triples every 12 months”.

All the development taking place since then lead to confirm the law. Most communication, broadcasting etc needed for exchange of information are becoming digital, faster & faster supported by ever increasing processing power of computers governed by Moore’s Law. The communication is becoming efficient and extremely affordable.

2.3 Metcalf’s Law

This law by Robert Metcalf, Originator of Ethernet & founder of 3COM states that “value of a network is proportional to the square of its number of nodes”. So, as a network grows, this value of being connected also grows. Internet has shown the value of connection.

2.4 Working of these laws Together

Applicability of 2\textsuperscript{nd} & 3\textsuperscript{rd} law follow from the efficiency of 1\textsuperscript{st} law. These combination are changing the complex system of thinking & management functions. It is also leading to multidisciplinary R&D, technology convergence and chaotic expansion in application. This aspect is discussed in the next section.

3. Technology Convergence and chaotic development
All the three laws of technology described in the previous section are working in symphony (fig 3.1).

Convergence of the 3 Laws of Technology

MOORE’s LAW (Processing Speed)  Gilder’s LAW (Increasing Bandwidth)  Metcalfe’s LAW (Power of Networking)

NEW PARADIGM / INITIATIVE

Figure 3.1

This has led to rapid shrinking of distances, cultural diversity and encouraging of multidisciplinary as well different domain specialists working on entirely different domain. One notices, today an electrical engineer involved in forecasting of stock prices or economic forecasting and vice-versa. In a way, one finds breaking a myth of specialists. Today the wonder chip which brought the synergy in the laws of technology is also acting as catalytic agent to facilitate professionals moving from one domains to the other and sometimes even stranger zones. This convergence of technology is depicted in fig3.2.
The criss crossing zone of multidisciplinary research after 1980s shows the era of technology convergence. One can note the chaos like chaotic flow. In such scenario, it is not possible to predict the future through reasons alone. As stated by Thomas Frey Futurist of ‘The Da Vinci Institute’ “When looking at the future the ‘What’ is far more predictable than the ‘When’ And the ‘how’ will always feel different than predicted”. This quote when further expanded in the laws of technology, we can say things will happen in certain time frame but how is not easily predictable. What will be the shape of Internet, two decades later, for example, is anybody’s guess. During 1990’s, no one predicted such an explosive growth of Internet.

There is however, a silver lining from the consideration of theory of Chaos of Lorenz, which states this in a chaotic conditions, the energy tries to gather around certain attractors. This aspect has been visualized in terms of various priorities in human efforts. This is presented in fig3.3. That shows the technology convergence will align itself for specific application in area of Health, Food, Education/Edu-entertainment, Entertainment, commerce and to varied extent defence/ offence. With this in mind, one is tempted to predict that most of the experts could be focusing their attention to develop one or more attractor domains.
Rapid growth is thus expected in the applications. For example, health could include development of chip embedded diagnostic tools, (new efficient drug discovery), efficient surgery (again based on embedded chips), nano robots for treatment of cancer & heart ailment, artificially created body parts, liver, heart etc. As one reads, the humanity is just a few steps away from cloning a human being. Should it be done, how it should be done? Such questions and many other form the part of ethics and are discussed in the next section.

4. The Fourth Law of Technology

The author has been involved in formulating a 4th law to safeguard the impact of chaotic development. The Coases law also termed as 4th Law, talks of transaction and complexity of expanding organization’s domain. But that is not what we have in mind.

We are concerned about the sustained development. Most often the delicate balance between the development and its overall impact on ecosystem is represented by an equilateral triangle of forces as shown in fig 4.1.

For sustainability the maintenance of delicate balance is absolutely essential. Once a balance is lost, without counter balancing the whole system could lead to an unknown zone, recovery from where may be very expensive, time consuming and difficult.

To provide a safety lock, we provide a 4th law based on ethics. It is believed if at every step, technology developers, keep in mind the end result, i.e. impact of growing technology and fast obsolescence on the ecosystem in general, the development can be perpetual and sustainable. The law is enunciated in the following form.
Technologists and scientists are encouraged to spend just 10 percent extra resources and time in planning and envisaging the end result which should lead to efficient, economically affordable and green eco-friendly technology. Ethics & value systems are more important in the current global scenario than a few extra gold coins.

This law, we, believe should be inculcated by the students & researchers to get the optimum benefits of this technology based knowledge era.

5. Philosophy of dynamic curriculum development

The curriculum developed has to be a continuous exercise. In a number of universities and colleges, the process of changing curriculum once implemented is sometimes tedious and time consuming. In the present state of ‘IT’ the process has to be fast and flexibility should be the important characteristic.

In a typical 4 year undergraduate course, we suggest the following philosophy keeping in view the entry of students from various streams, rapid growth of IT & its application according to the laws of technology, major stream of application as depicted by attractors and finally drill of “Ethics” as enunciated in 4th law. Steps are listed below:

i) To bring in the homogeneity among students of different streams, 1st semester and part of 2nd semester may consist of bridge papers to bring uniformity in the level of understanding. Both semesters could have introductory papers on ‘IT’ including Internet, basic sciences & mathematics.

ii) Semesters 3&4 to concentrate on core papers of Computer Sciences, Telecommunication and management of IT system. Each semester will have a paper in Mathematics. 4th Semester may have one compulsory paper in Ethics.

iii) At the level of Semester 5&6, the curriculum can be split in various streams like IT application in Agricultural & agricultural production
system, IT application in Health sector like Bio-Informatics, Robotics, E-Commerce etc.

iv) Semester 7 may cover emerging areas on typical streams based on the choice of students and/or teacher. There could be term papers as assignment to review recent development in the area of choice. Here one wants to expose the students (indirectly teacher) to the emerging cutting edge technologies in the respected stream.

v) Semester 8 may contain one or two special papers & major project.

In the current scenario, one does’nt expect every institute to provide courses for every domain of specialization. Individual institutes could provide one to two disciplines of specialization. Students, then could select the institute based on their discipline of interest. This could also help foster better research facilities.

6. Concluding Remarks

In this paper a procedure has been suggested to develop curriculum to meet the challenges of rapid development & fast obsolescence. Lessons have been derived from the three laws of technology, chaotic growth with attractors. A 4th law on Ethics has been formulated.

This law on ‘ethics of technology development’brings out the importance of ethics & value systems to ensure sustainable development without disturbing the natural balance.

The strategy of curriculum development in a flexible manner, to meet the needs of the society in this chaotic state, has been presented. It is believed that this strategy will help student community to better face the impact of rapid development of technology as well as fast obsolescence.