

# **Digital and/or biological essentials for novel liberal education required for raising future innovators: A perspective position article learning from scientific revolutions during the renaissance and the age of enlightenment**

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## **Summary**

Nowadays, the liberal education hardly survives nor thrives in the universities world-wide. While liberal studies are still needed today, we have to seek for possible and ideal forms of liberal education to be provided in the higher educational institutions in Japan despite most Japanese universities are further willing to focus on the much more specialized and/or applied studies rather than liberal educations. One of the likely approaches for reviving the liberal studies is to refurbishing the topics to be covered. In the present perspective position paper, the author discussed the necessity and possible forms of future liberal educations in order to raise and release the novel types of human resources capable of not only adopting to but also pioneering and innovating the future society. In the early sections, views on the liberal studies through historical time span was brought about and discussion led to the vision that future innovators should be able to be benefitted by (and accessible to) the liberal knowledge as if “standing on the shoulders of giants.” Then, importance and necessity of open multi-disciplinary visions shared by both scientists and ordinary people were discussed. From the history, we can learn that there

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used to be specific periods represented by the growth of science led by multi-disciplinary giants of knowledge (the many-sided men) especially in the renaissance in Italy (14-15th centuries) and enlightenment movement in wider Europe (late 17th to early 19th centuries). Lastly, novel liberal educational programs for raising the novel type of many-sided people belonging to both science and humanity schools, educated and skilled in digital and bio-sciences (in addition to traditional liberal studies) are proposed.

## **1. Introduction**

Nowadays, the liberal education which was historically derived from the catholic seven liberal arts, hardly survives nor thrives in the United States (and also in the rest of the world) (Breneman,1994). Instead, specialized education dominates the sceneries in the universities world-wide. While liberal studies are still needed today, we have to seek for possible and ideal forms of liberal education to be provided in the higher educational institutions in Japan despite most Japanese universities are further willing to focus on much more specialized and/or applied studies rather than liberal educations. One of the likely approaches for reviving the liberal studies is to refurnishing the topics to be covered. A British educational scholar, Eric Ashbby who had deep contact with Russian biologists, has proposed a process for modernizing the liberal studies, after inspired by biological processes, especially of evolution (Ashbby, 1971, 1974). Accordingly, there should be frequent chances for introducing new topics or curricula and to eliminate the unnecessary one, in order to broaden and reshape the range and forms of liberal educational programs. The author believes that the message by Ashbby encouraging the changes in universities making themselves adapting to the drastic technological changes, emitted almost a half century ago, still shines even today, or much brighter ever. In the present perspective position paper, the author wishes to discuss the necessity and possible forms of future liberal educations in order to raise and release the novel types of human resources capable of not only adopting to but also pioneering and innovating the future society.

## **2. Viewing liberal studies through historical time span**

Let us start the discussion by mentioning the personal memories. More than 25 years ago, the author was an applied science student (majoring biological and chemical areas related to

agriculture and environments), and without being aware of the importance of liberal studies. Fortunately, the author had a chance to widen the view through direct and kind contacts with Prof. Toshichika Miyata of Miyazaki Medical College, who actively authored (Miyata, 1991) and translated (Ashby, E., 1971, 1974; Breneman, 1994; etc.) several books highlighting the important historical and social roles of Liberal Arts Colleges among the oldest American institutions.

Upon inspiration by the idea emphasizing the human-leading roles for liberal art studies, the author started to view the whole science and technologies (including biology and related technologies) with historical time-span. My such attitude somehow continued for decades and led me to collect some tons of century-old science history books mostly from European cities (Paris, Bonn, and Florence) (Kawano and Bouteau, 2007; Kawano et al., 2008), and I could have reach a view that science students can be successfully transformed through deeper and basic learning of liberal arts and *vice versa*, non-natural science students majoring social sciences or humanities must have certain level of “inter-science literacy” through liberal studies covering science topics.

### **3. Future innovators may stand on the shoulders of giants**

Said Isaac Newton: “If I have seen further, it is by standing on the shoulders of giants (Turnball, 2008).” Innovation never comes out of nothing, but combination of a bit of ideas and the knowledge on the discoveries achieved by earlier scholars help us discovering something really new or squeezing some novel knowledge, even in the fields of experimental sciences. It is trivial that the “giants” in the history of science themselves achieved their works through the “chemistry (conjunctions)” of basic studies covering the preliminary known discoveries (achieved by much earlier scholars) and the hypothetic new ideas to be added. I believe that the learning experience through liberal studies surely bottoms up the quality and productivity of the above knowledge making processes.

This view is applicable not only to educate young scientists but also to inspire the artists. The secret of high productivity in many different fields is “letting dead people do your work for you,” said Robert J. Lang, Editor-in-Chief of the IEEE Journal of Quantum Electronics, emphasizing the fact that application of mathematical principles discovered by scholars in the past (dead people) helps us achieving a novel work such as the computer-assisted arts of origami

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(Lang, 2008). Dr. R. Lang is now recognized as one of the world's leading masters of the art, through newly designing over 500 highly sophisticated paper craft works.

#### **4. Importance of open and multi-disciplinary visions**

We have to be aware of the danger attributed to the excessive specialization of sciences which visualizes the exaggerated microscopic images of minute sections but not the whole image of the intact world we live in. As many people may still remember, the climate research controversy known as “Climategate” took place at the University of East Anglia (United Kingdom), in 2009. The news of “The Hockey Stick Illusion” telling the scandalous case that a number of sincere scientific works willing to report the “inconvenient truths” NOT supporting the still hypothetical but politically correct “global warming theory” have been inappropriately rejected through the peer-reviewing system governed by the core group members (Montford, 2010), really shocked us. Then, the reliability of the peer-reviewing system backboneed by the “intra-sectionalized science literacy” among the small groups of scientists was largely questioned (see Steyn, 2015). This was a truly sad case and also a symbolic event by which we could have realized the necessity to bring about more open discussions on the highly specialized topics, regardless of so-called environmental and political correctness (political theology today), through the multi-disciplinary points of views supported by the educated public.

It is tempting to propound that the foundation of the multi-disciplinary visions obviously relies on the quality of liberal studies. This multi-disciplinary approach may confer powerful “inter-science literacy” both to the specialized scientists and to the non-specialized ordinary people, allowing us to understand the frameworks of the discussion and to judge the quality and direction of the debates on the highly specialized but important topics influencing our life and future, such as environmental issues.

#### **5. Future innovators are expected to be novel “*Uomini universali*” or “*Hommes des Lumières*”**

History of liberal studies could be clearly dated back to the early academic activities, which was achieved mainly through debates among students and professors in the prototypic universities emerged out during the renaissance time in Italy. Therefore, development of liberal studies had necessarily coincided the development and growth of sciences achieved by academic

communities basing in early European universities.

European history of science tells us that there used be a few but distinct golden ages of human intelligence. It is highly impressive that a massive number of multi-disciplinary academic giants appeared in the age of renaissance in Italy (especially around Florence; chiefly, Leon Battista Alberti, Michelangelo, and Leonardo da Vinci) and later, in the period coinciding the industrial revolution and the age of the enlightenment intellectual movement (Siècle des Lumières) over Europe (namely, Isaac Newton, Jean-Jacques Rousseau, G.W. von Leibniz, Voltaire, Denis Diderot, A.-L. de Lavoisier, J.W. von Goethe, C.F. Gauss, Michael Faraday, and Charles Darwin), and consequently, their works have drastically changed the shapes of the world (as partly discussed in my previous works: Kawano, 2013; Kawano et al., 2013; Yamada and Kawano, 2014). The generation of iconic renaissance scholars (such as Leonardo) represents the era of “*Uomo Universale*” (plural: *Uomini Unversali*; universally educated people) and the generation of productive scholars from Newton (of 17th to 18th centuries) to Darwin (early 19th century) may represent the era of “*Homme(s) des Lumières*” (enlightened people). From United State, Benjamin Franklin (and possibly Thomas Jefferson too) should be added in the list of “*les Hommes des Lumières*”.

In fact, “*Uomini Universali*” and “*Hommes des Lumières*” listed above were highly multi-disciplinary backboneed, often deeply majoring several different disciplines. For example, Jean-Jacques Rousseau, an iconic Francophone philosopher, writer and composer of 18th century, had left a series of botanical books, and notably, he also documented an insight on the evolutionary significance of natural selection (even before Charles Darwin). Furthermore, J.W. von Goethe, known as an iconic German writer and poet, brilliantly invented his color theory (physics of light, similar to the Munsell color system we use today), proposed ideas on the morphology of plants and animals (basis of evolution), and largely contributed to geo-chemistry through observation of a number (>16,000) of rock specimens collected by himself.

In contrast, scientists today (both natural and social) are keen on focusing only on the highly specialized topics, and therefore, communications between the scholars belonging to different scientific communities became highly difficult today as if the age of Rousseau and Goethe has gone forever.

Today, we are facing the difficulties in global managements of food, resources and energy; global climate changes (real events apart from the “hockey stick-shaped graph”); and human population dynamics (including the on-going migrant crisis); despite the intensive efforts by

highly specialized experts. I believe without doubt, that “*Uomini Universali*” must be revived today, possibly through intensive liberal studies. Note that the word “*Uomo Universale*” is not an antonym of “specialist”, thus an “*Uomo Universale*” should not be considered merely equal to a generalist. Instead, by definition, an “*Uomo Universale*” must be sharply specialized in multiple different disciplines in the academic and intellectual spectra from the natural sciences to the arts.

## 6. Many-sided men from Germany

It was a German idea defining the Italian Renaissance, as Jacob Burckhardt (1818-1897) named it in his book “*Die Kultur der Renaissance in Italien*” (Watson, 2010). In the above sections, characteristics and historical significances of *Uomini Universali* and *Hommes de Lumières* were briefly stated. Peter Watson in his book “*The German Genius*,” gave an English name to those historical multi-disciplinary superstars as the “many-sided men,” and thus Renaissance in Italy and the *Siècle des Lumières* in Europe (covering Germany, France and United Kingdom) as “the eras of many-sided men” (Watson, 2010).

Interestingly, according to the discussion in the aforementioned book “*The German Genius*,” the eras of many-sided men based on the rediscovery of Western wisdom or classical revival of the Greek philosophy occurred at least three times in the past. Accordingly, this view was originally presented by Charles Homer Haskins, Prof. of history at Harvard, stating that the first Greek revival associated with the rediscovery of Aristotle, took place in Italy, in the twelfth century and left the intellectual legacies such as new science of law, unified legal system, wider use of Latin, development of universities, growth of organized skepticism in scholarship, *etc.*

The second classical revival in the West was Platonic revival occurred again in Italy, in the fourteenth and fifteenth centuries, which gave rise to the Italian Renaissance, associated with the rediscovery of Plato’s texts and the civilizations of ancient Greece and Rome before the influence of Christianity, led to the growth of textual criticism, advancement in linguistics, and revived learning in philology; as symbolized by the reorganization of Roman university, *La Sapienza*, led by Pope Leo X.

In Florence, Italy, platonists had spread massive influence among the philosophical scholars, eventually altering the ways of thought on literatures and the mode of aesthetics. Importantly, advancement in natural history took place in Florence and surrounding area including Pisa, represented by the emergence of the first botanical gardens (in Pisa and Florence) developed

for advancement of botany (medicinal use of plant specimens) and the organized collections of foreign animals contributing to the development of zoology (Kawano, 2015).

Note that the giants in art during this Florentine era such as Leon Battista and Leonardo da Vinci were typical cases of “many-sided men” achieving legendary works in many different fields. The most influential Japanese popular text pointing the significance of *Uomini Universali* emerged out of Florence was the series of essays by Nanami Shiono, a novelist known for works dedicated to the Italian history, actively covering ancient Roman and the Renaissance periods (Shiono, 2008).

The book of Watson mentioned above (Watson, 2010) further highlighted the rise of science in Germany in the era corresponding to the Siècle des Lumières and the industrial revolution as the Europe’s third renaissance and also as the second scientific revolution (counting the Florentine era as the first scientific revolution).

## **7. Anton Karsch as an example of German many-sided men, bridging philosophy and a number of fields in natural sciences**

*All truly wise thoughts have been thought already, we must think them over again honestly*

Johann Wolfgang von Goethe

It is true that we often face the situation that a newly invented idea has been already proposed and tested by someone else in the past, in a similar or different form. Alexander von Humboldt could be the chief giant contributing to the foundation of natural sciences, since many ideas in natural science have been already named after him than anyone else (Wulf, 2015). Thus, Humboldt could be the representative of the German science revolution. A number of scientific and scholarly giants or superstars such as Goethe, Leibniz, Nietzsche, Schopenhauer, *etc.* could be found in the era of the German science revolution (or Siècle des Lumières), here, the author wishes to further emphasize the stories of non-superstars but representing the majority of ordinary scholars who shared the same era in the same geographical area, possibly filled with the atmosphere of the multi-disciplinary academic attitudes. By highlighting the works by Anton Karsch (1822-1892) as a model personnel who was a non-superstar of German enlightenment movement but left solid works with multi-disciplinary academic attitudes.

We have previously described a story we experienced in our plant biological research that we have found and been shocked by, a similarity between the recently proposed plant pathological

model and a classical proposal (Kawano et al., 2013; Kawano, 2013; Kawano and Bouteau, 2013). Previously, we have documented three articles on the “pioneering works” of a German scholar, Anton Karsch who was raised in the academic atmosphere of the age of Lumières in 19th century Europe. In 1855, Anton Karsch, as a funding editor and also as an active author, published a series of works suggesting the role for intercellular space in plant tissue as the paths for infection by and the spread of pathogenic microorganisms and also for cell-cell communication required for plants to combat against the invading pathogenic microorganisms. It is also noteworthy that the entrance of air-borne spores of pathogenic fungus into the leafy tissue through the opening stomata which is recently studied by plant cell biologists, has been already described by Karsch. Anton Ferdinand Franz Karsch, who authored most of articles and books as Dr. Karsch, was known as (i) a medical doctor (internist), (ii) an ecologist (covering both insects and plants), (iii) a plant collector, (iv) a microbiologist (engaged in both basic and pathogenic cases), (v) an early cell biologist, and (vi) an philosopher; born, brought up, lived and died in Germany. His life was dedicated to the collection of the natural pieces of the region of Westphalia. The works of Karsch as a locally acted ecologist has been well recognized among the scholars and his book focusing on the Westphalian biota/flora has been frequently revived and still available today.

The works of Karsch appeared in 1855, as seven different articles in the very first issue of the first volume of a Germany-based inter-disciplinary academic journal covering both science and philosophy, named “Natur und Offenbarung (Nature and Revelation),” preceding the launches of “Nature” (1869) and “Science” (1880). As one of four founding editors of “Natur und Offenbarung” which lasted for 36 years (1855-1891), he kept making great efforts for filling the space in the journal. In his editorial and authoring activities, he has fully performed his academic capacities backed by his interdisciplinarity reflecting the age of enlightenment. A part of philosophical works (Karsch, 1855a-c) intensively dealt with the idea of “thing-in-itself” (ding an sick) proposed by a German philosopher, Arthur Schopenhauer (1788-1860). Karsch was also interested by the use of microscopes which was surely considered as a state of art “new technology” at that time and eventually authored three articles entitled “Mikroskopische Lebensformen 1 & 2” (Karsch, 1855d, e) and “Aus dem Leben einer Mücke” (Karsch, 1855f), describing the microscopic structures of bacteria, protozoa, blood cells and insects. Interestingly, his scopes also covered the behaviors of higher plants surrounded by pathogenic microorganisms (Karsch, 1855g). We have compared a piece of Karsch’s works with a plant pathological model proposed today and suggested that both the classical and recent works are commonly



indicative of the role for intercellular space in plant tissue as the paths for spread of pathogenic microorganisms and also for cell-cell communication required for combatting the invading pathogenic microorganisms (Kawano et al., 2013; Kawano, 2013; Kawano and Bouteau, 2013).

We have to learn such academic attitudes as a many-sided scholar bridging the different fields, which we largely lack today.

## 8. Digital literacy and Liberal studies

An Italian scholar, Prof. Stefano Mancuso (Univ. of Florence, Italy) authoring the recent world-wide best-selling book “Brilliant Green” (Verde Brillante, presenting his molecular cell biological and philosophical views comparing living plants, human being, computer theory, and robots) (Mancuso and Viola, 2015) and the most recent book “Plant Revolution” (Mancuso, 2017), is a good example among re-emerging Italian many-sided scholars today. In order to answer a simple but difficult question <what is life?>, he is now enjoying a life-long liberal studies by building a global collaborating networks involving biologists, chemists, physicists, computer engineers, artists, philosophers, journalists, and even an audio equipment manufacturing company. The starting point for him was to understand the forms of life as plants (Pollan, 2013). As seen above, the liberal studies required for this purpose must be highly intensive and well systematized. Universities today, are responsible for designing and providing education for young generation in order to outreach the social demands in such direction.

I sometimes imagine if Leonardo and Michelangelo were born today celebrating the new digital age; they must be mastering all necessary digital tools to express their passions and ideas in arts and science. I am confident with my imagination that *Uomini universali* today must be fully armed with digital literacy.

Universités Canada, a Canadian national organization representing the universities and colleges in Canada recently conducted an open discussion on the future of the liberal arts and concluded that “the digital revolution occurring today may pose both an imperative and an opportunity for the liberal studies” (Universities Canada, 2016). There is a positive point of view that computer technologies and new digital tools provide us new and diversified ways to achieve research, to teach, and even to share knowledge among scholars and also with students. Prof. Kevin Kee (Dean, Faculty of Arts, Univ. Ottawa) described such digitally driven changes in liberal studies/educations in most universities today as “Humanities in the Zettabyte age”

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(Universities Canada, 2016). In coming Zettabyte or Exabyte ages, the digital literacy will gain greater importance as the basis for starting the liberal arts education.

## **9. Bio is the Next Digital**

Massachusetts Institute of Technology Media Lab's former chief, Prof. Nicholas Negroponte said "Biology is the next digital." This has been repeatedly propounded in various media by his successor Prof. Joi Ito (Ito, 2016), implying by analogy to the "digital revolution" that the on-going very fast developments in bio-related sciences may drastically alter the shapes of the world in the near future. This means that people, not only specialists but also an ordinary business person, must develop a least literacy in bio-sciences and technologies. The basics in molecular biology (studies on DNA, RNA, and proteins), cell biology (chemical biology handling living cells), and bioinformatics would be the starting points for most of young students.

In cases of digital humanity movements such as "Humanities in the Zettabyte age" movement in many leading universities, the university librarians are playing more and more important roles, by intensively helping students navigate new digital learning spaces (Universities Canada, 2016). Similarly, Universities today must provide equivalent educational specialists who would play such key roles for literacy development in biosciences, the "next digital," in order to respond to the increasing social and environmental demands.

## **10. Possible actions starting in Kitakyushu**

We need to share the idea for introducing the evolutionary action (according to the Ashby's model) altering the form of liberal art programs to be provided at the University of Kitakyushu (UoK). The likely actions at the environmental engineering school should be introduction of the informatics-assisted bioscience and related disciplinary views to the engineering curricula. In turn, the likely actions we can initiate in other schools (such as of Economics and Business Administration; Humanities; Laws; Foreign Studies; and Regional Development) may include introductory courses for both basic informatics and bioengineering for non-science students gradually guiding to and bridging the related liberal studies and science historical lectures connecting social science and humanities.

In case of engineering education, so-called on-the-job training (OJT) is one of key practical

approaches in which students and graduate students learn the principals of science through actual research activities on the specific topics. Therefore, it is also important to showcase the conjunction of multi-disciplinary research examples performed *via* interschool collaborations among labs and faculty members belonging to different schools majoring different fields of science. For instance, introduction or application of biologically popular mathematic models for solving the problems in economics such as modeling of the "law of diminishing marginal utility" with Hill equation would be challenging (one of proposed collaborations with Prof. Ushifusa, School of Economics).

I dream of the days in the near future, UoK would be recognized as one of cores of renaissance-like multi-disciplinary intellectual movement releasing internationally active scholars, artists, business people, and politicians with well-developed inter-science literacy.

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