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Guest Editorial

Trans-disciplinarity

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I. Introduction

Over the past two centuries, human culture has been split into two categories, science and technology, and the humanities and arts. Furthermore, science and technology have been minutely divided into clearly specified disciplines. Thus, it has become hard to understand other disciplines at a professional level because of the intellectual walls between disciplines. The maturity of science and technology, however, has made it increasingly difficult to obtain new findings and breakthroughs only within one's specialized discipline. New findings and technical breakthroughs are often accomplished only by bridging the gap between completely different disciplines, and this has been true for many years. For example, Newton's system of classic dynamics was created by combining the concepts explaining the motion of astronomical objects and the falling of an object, traditionally said to be an apple, to the ground. Darwin's theory of natural selection was an analogy of the competition in a free market described by Adam Smith. Atomism and reductionism originally came from the projection of the hierarchical structure of human language to nature by Democritos.

Although many scientists and scholars have recognized the importance of a multidisciplinary approach, it is still very difficult to transcend the borders of disciplines in practice. Such conceptual transitions have generally been made by people now considered geniuses. Current inter- or multi-disciplinary research organizations are not powerful enough to overcome the walls between disciplines, and inter- or multidisciplinary research organizations often have not functioned as well as expected because they have been based upon only a bundle of closely, or sometimes not so closely, related disciplines. The author believes that rather than a static concept, a dynamic concept is needed to overcome this difficulty, and to bridge and fuse disciplines to enable the evolution of new comprehensive fields, e.g., mind-brain science, environmental science and educational science.

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II. The history of our divided culture and its unification

In ancient Greece, disciplines were not so strictly categorized, and the great minds of that age moved easily between various fields of thought. Pythagorians (6 century BC), for example, simultaneously studied philosophy, mathematics, music, and religion. In this age, the words "symmetria" and "asymmetria" appeared to described the concept of divisible versus indivisible, for example, that the ratio of the diagonal versus the side in a square was not an integer. Aristotle (BC 384–BC 322), and other Grecian scholars studied both nature and humanity as natural philosophy. This tendency continued after Rome conquered Greece, and De Rerum Natura by Titus Lucretius Carus (ca BC 94–BC 55) is a typical example of this. However, a division soon appeared between what is now considered the natural sciences and the humanities during the age of Imperial Rome. This division persisted in western culture, but was much less apparent in eastern cultures.

During the Renaissance, though, Leonardo da Vinci (1452–1519) and many others, transcended this division between science and the humanities. Johann Wolfgang von Goethe (1749–1832) also achieved this, having written both Faust and The Theory of Color. Interestingly, Goethe was opposed to specialists in science, who were starting to appear at the beginning of our modern industrial age.

In the modern age, which has been heavily influenced by western philosophies, the scientific way of thinking divided culture very precisely due to the influence of reductionism. The original meaning of "sci-" in the word "science" means "dividing". Rene Descartes (1596–1650) discussed the equal importance of analysis and synthesis in his Discours de la Methode. However, many people have recognized the importance of only analysis because of its great contribution to the progress of science and technology. Now the value of synthesis, though long neglected, is considered increasingly important, even in science and technology. The ability to take a trans-disciplinary approach to comprehensive disciplines, such as mind-brain science, environmental science and educational science will be essential in the 21st and later centuries.

III. The concept of trans-disciplinarity

Figures 1(a) and (b) show the difference between the concepts of inter- or multi-disciplinarity and trans-disciplinarity[1–2]. We began to use the term multi-disciplinary instead of inter-disciplinary in the early 1990s to indicate the comprehensive nature of this field, and because it is very different from underdeveloped niche academic fields that slightly overlap well-established disciplines. New comprehensive fields, however, such as mind-brain science, environmental science as well as educational science, cannot be looked upon as a mere bundle or a simple combination of many related disciplines. Such fields apply the essence of knowledge and philosophy taken from many related disciplines to form their own conceptual structure, a structure that may transcend the borders of many natural sciences, social sciences, and even the humanities. The concepts of inter-disciplinary or multi-disciplinary are situated on a two-dimensional plane, but the trans-disciplinary concept occupies a three-dimensional space as shown in Fig. 1(b). The trans-disciplinary concept exists at a higher hierarchical level produced by the linkage of several different disciplines at the lower hierarchical level. Trans-disciplinarity includes the concept of bridging and fusion between completely different disciplines.

Each discipline evolves by itself in terms of a conventional methodology and research organizations. However, some driving force is needed to bridge and fuse disciplines and propel the evolution of a new comprehensive discipline that will require new methodologies and new research organizations. When collaborations occur within the multi-disciplinary plane, the comprehensive discipline only evolves at the rate of the evolution of each component discipline. A simple combination of multiple disciplines is not enough to drive the trans-disciplinary vector in Fig. 1(b) in the direction perpendicular to the multi-disciplinary plane, which is the direction that a new comprehensive discipline will evolve in. There have been a number of experimental trials and proposals concerning multi-disciplinary research and development, but these have been somewhat disappointing because the driving force perpendicular to the multi-disciplinary plane was inadequate. Therefore, we need to create a new methodology and new organizations, including a common language that makes it possible to transcend the borders separating disciplines. The author has proposed that "analytical science" (or analytics) is capable of acting as a possible driving force that can lead to a transcending of disciplines. This is a generalized concept and methodology that can be shared across disciplines [3–4].

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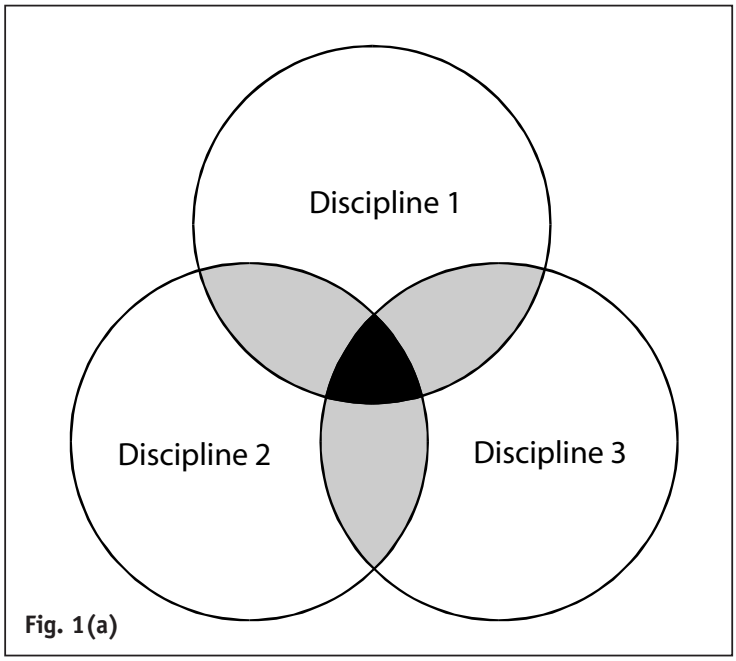

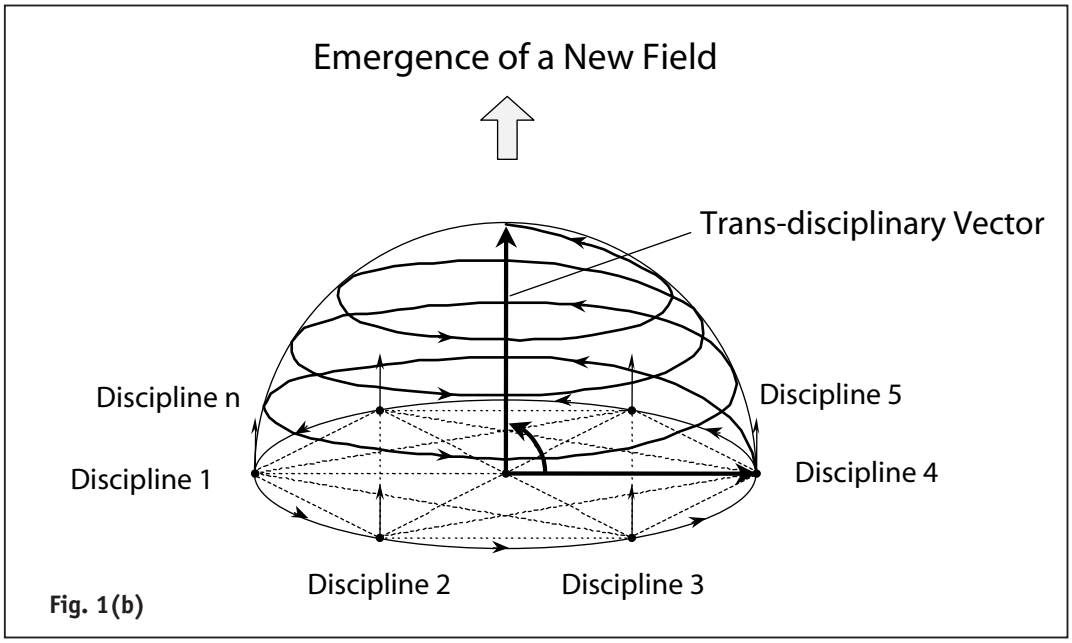

Fig. 1. The difference in the concepts of trans-disciplinarity and inter-disciplinarity (multi-disciplinarity). (a) Inter-disciplinarity (Multi-disciplinarity). (b) Trans-disciplinarity.

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