



DIVERSITY AND NATURE

ADRIAN BEJAN

Duke University, Durham, NC, USA
abejan@duke.edu

This article explores the causal relationship between freedom, the imagined (perfection), and the observed design in nature (diversity). The presentation is with familiar examples of perfection and diversity over space and in time: the configurations and rhythms of moving and changing designs of people, animals, athletes, technologies, universities, and science itself: divergent evolution hand-in-glove with convergent evolution.

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Freedom is the cause of everything, from change and imagining to observing and describing, and from the inanimate to the animate diversity of flow designs in nature. Freedom is the collection of physical features that enable an object to change. Freedom is measurable in physics (*e.g.*, the number of degrees of freedom and the effect of more degrees on performance). Without freedom, nothing changes, nothing moves, and nothing is different from before.

Why does nature ‘select’ diverse forms from diverse media (water, land, air), not from one template, and not of one size? After all, in the struggle for ‘survival of the fittest’, clear winners must have been selected millions of years ago. Nature is quite different. Diversity is everywhere, around us, among us, and inside of each of us. Diversity is natural, a defining feature of nature.

What causes diversity?

When hearing words repeated in unison by the crowd, I reach immediately for my Webster’s dictionary. Diverse comes from Latin: *diversus* is the past participle of the verb *divertere* (*dérouter* in French), to turn aside, as something different, dissimilar. Diversified means varied. Diversity is the quality of variety. Greater diversity (a distinct phenomenon in nature) comes from more degrees of freedom. This is the cause and direction of design evolution in the observable nature.

Diversity is a natural feature. Unnatural is the one category, such as the one size fits all, one color, brown shirt for fascism, red scarf for communism, one idea for an ideologue. Unnatural are the two categories, such as fascism and Marxism, oppressed and oppressor, proletarians and factory owners, healthy origin versus unhealthy origin, and under-represented and over-represented. Such policies are discrimination and *polarization*, not diversity.

Diversity is common sense because it happens naturally, not artificially. Diversity is not the result of dictate. Weeds appear among shrubs in the most carefully plated vineyard and apple orchard. Mutts are born every day. Mothers give birth to diverse children who grow up to have amazingly diverse ideas.

In science, features and phenomena tend to go unnoticed if they are present everywhere. They are noticed only when they are in contrast with a background filled with the usual stuff. They are noticed only if they are unusual.

Diversity is common, everywhere. It seems ‘unusual’ when we are forced to impose diversity on society, enterprise, university, competition in athletics, and the merit system. Whether this has a future is for the reader to conclude. To help the reader, I decided to question the *physics* origin of diversity – why diversity happens naturally, why it is a phenomenon that has a mind of its own, and why it successfully opposes any effort of being reduced to two or three categories by dictate.

In resorting to physics to *predict* the natural origin of diversity, I continue on the path traced by my peer-refereed research, which is being condensed chronologically in books such as [1–5]. I chose physics because physics is not opinion. Everyone is entitled to his opinion, and so am I, because I am one of you. Physical facts and behavior are quite different. They are observable, and an idea about them can be put to the test.

This, the questioning of the idea, has been going on forever in the evolution and emancipation of the *homo sapiens*, which is why today we have science, and why we will never have enough science. So, I invite the reader to question every new slogan and flavor of the day, to separate jargon from common sense, to detect coincidences, to question what caused them, and to draw conclusions that benefit the reader, the individual, and the next generation.

Coincidences are invitations to start digging in a new place. As we dig deeper, we uncover the natural origin of seemingly disparate phenomena such as divergent evolution hand-in-glove with convergent evolution, and rhythm in time hand-in-glove with diversity in space. In short, we discover why not everything should be big, small, or one size.

The presentation is a pictorial review of the physics principles that account for all the moving, changing, and predicting that go on in nature and science. It is a common-sense review because it is addressed to everyone. It is not jargon. It is about the directionality that unites the dynamic and changing behavior called nature. The single word for all such descriptors is *evolution*.

In Turin last year I showed how diversity happens naturally, and why ‘perfection’ does not, and will not happen. Perfection is a condition of complete excellence, faultless, and most excellent. Perfection (from *perfectus*, in Latin) means complete in all respects, without defect or omission, flawless. The demonstration was made in simple terms: the shape of an inhabited area affects the movement of people and their access to the area. The defining feature of life is movement with directionality (purpose, objective), not with perfect design or ‘end design’. Movement requires *access* to the available space in the available time.

For example, the mathematical optimum (the best) shape and an identified class of diverse shapes differ little concerning performance. The difference between the best and the diversity is rooted in the difference between rigidity (fixed idea, ideology, arrogance) and the freedom to question the supposedly best idea, and the ability to say, ‘enough of this’ and move on.

Several phenomena of diversity are presented after this introduction. In every example, the same image (idea, mental viewing) jumps at you. Coincidences are precious. Their message is that a universal phenomenon is in play in seemingly disconnected domains: human movement, animal movement, athletics, rhythm, cost, construction, enterprise, and university. The challenge is to translate messages from many domains into one language and a design science with further reach and greater usefulness.

The simplest model can change because of a single degree of freedom, but it cannot capture nature completely. The moving animal is much more than a vehicle with speed and size. The animal is also an engine and a steadfast discoverer of fuel (food) for its engine. In the direction toward greater realism, the necessary degrees of freedom multiply, and so does the size of the diversity of designs that offer nearly the same performance as the perfect design. In aquatic movement, many features account for the diversity of *rhythm* during the moving cycle: arms, legs, body architecture, pulling oars (rowing), and so on. With animal and human examples from swimming and flying, we trace the path from multiple degrees of freedom to greater diversity in lifestyle, training, technique, performance, technology, and robotics.

Coincidental is the discovery of another source of natural diversity: Divergent evolution happens at the same time as convergent evolution. A lot is known about the convergent evolution of the body shapes of fish, swimming mammals, and birds (*e.g.*, whales, dolphins, penguins). Submarines look like orcas. But, the cross-sectional shapes of fish and mammals are quite different, oval versus round. Round is also the cross-section of the fuselage of

commercial jet airplanes. Although the evolution of airplanes converges with the evolution of birds, the evolution of helicopters diverges from airplanes and birds. Together, divergent with convergent evolution broaden the reach and impact of the diversity phenomenon.

How useful is it to know that being fixated on perfection (and overlooking the gathering clouds of diversity) is not the way to make progress? Well, the truly inventive and enterprising individuals know the answer instinctively. They do not waste time. They keep what works and devote their time to new challenges and ideas. Enterprising folks know that if they keep improving something to perfection nothing will happen, except waste of time, power, money, and zip.

In science and academia diversity happened naturally, over centuries, not because of the recent push for ‘diversity, equity, and inclusion’ (DEI). Seen from the outside, the diversity of academia is evident in the rankings of universities. From the inside, universities are diverse because of a huge variety of features: age, size, fame, ideas, and individuals (students, professors, alumni, culture, religion, country of origin, maternal language, parents, schooling, *etc.*).

Rankings lend artificial structure to the diversity that occurred naturally over the long history of the growth of the world university system. Yet, we hear constantly what a university must do to game the system, to increase its ranking by design: one must make the university bigger and more diverse. From high administrators on down, we keep hearing that size matters, and diversity matters. Well, a wise specimen of *homo sapiens* is known for not being too sure, and for the ability to question himself and others.

I knew that the size and diversity effect on rankings is false because I was raised as an athlete. In sports, it is common knowledge that to lift your team in the standings you must watch and learn from the better players and teams, and then try harder to become better yourself, you, the player. So, the solution is to study Harvard and strive to do better what Harvard does. During my eight years at MIT, I knew that Harvard was neither big nor diverse. The same was true about MIT. These two, along with a few other institutions, rank high in public opinion because of features other than size and diversity by design. What are those features?

Answers come from a bird’s eye view of the facts. Effect betrays cause. This way we learn that the university ranks are correlated with the quality and number of precious ideas that come primarily from a few thinkers hosted by a few universities.

To think that one can game the system artificially to overtake Harvard in size and diversity is to go against nature. If one seeks to be ranked above Harvard, why not look at Harvard and do what Harvard does? If one believes that greater diversity leads to higher rankings, then why would one want a demographic composition that differs from that of Harvard?

Why is this useful to know? Because, by understanding the physics principles that underlie natural phenomena, people can position themselves and their society better in nature, can put the natural phenomena at their service, and can avoid fighting losing battles.

Useful to know is the origin and history of the thinking that by force one can ‘sculpt’ the diversity of an organization (or society) to make it achieve a predetermined performance.

Science is about us, for us to use to our advantage or to dismiss at our peril. Do not worry, you will always be saved by ‘doers’ who create quietly and often alone. This way, the advanced people keep advancing. Keep these thoughts in mind as you read my article.

Nature has a mind of its own.

Perfection: you may imagine it, but it never comes.

Diversity: you can’t imagine it, but it always comes.

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