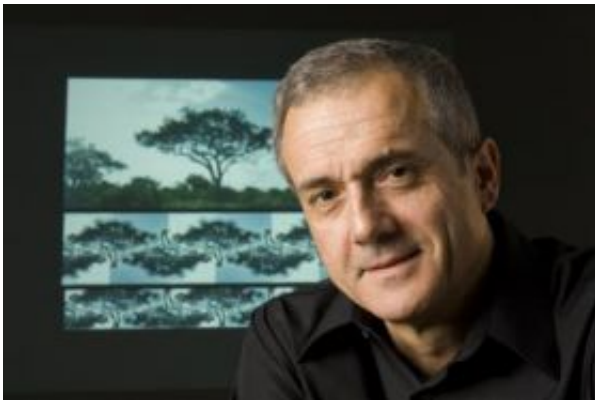


Collaboration of soloists makes the best science

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Adrian Bejan. Credit: Duke University

For the success of a major research university, which is better: large, well-funded laboratory empires with many investigators working toward the same end, or the individual scientist toiling alone in his own laboratory or at his own desk?

According to a novel theory by a Duke University engineer, the optimum situation appears to be a balance between the "many" and the "one." Institutions benefit the most from the co-existence of large groups that self-organize naturally and lone scientists coming up with new ideas.

The researcher, Adrian Bejan, J.A. Jones Professor of Mechanical Engineering at Duke's Pratt School of Engineering, argues that while the

trend at major universities is the creation of large research groups focused on a particular problem, the individual researcher will not disappear. His analysis, which was supported by the National Science Foundation, appears in the December issue of the *International Journal of Design & Nature and Ecodynamics*.

"The history of scientific achievement is marked by solitary investigators, from Archimedes to Newton to Darwin," Bejan said. "Solitary thinkers have flourished throughout history because it is natural – science is good for the mind of the thinker and for the well-being of society. Even though the trend is toward the creation of large research groups, the individual will always flourish."

According to Bejan, the course of modern research changed abruptly after Oct. 4, 1957, when the Soviet Union became the first nation in space by launching the satellite Sputnik. What ensued, especially in the U.S., was a national rush to organize a massive scientific response to counter the Soviets.

As the most recent "trigger" of change in the direction of research, Sputnik led to a dramatic increase in the funding of large research groups within institutions already known for their research. This model was adopted by smaller institutions, which also began forming larger groups to attract funding, Bejan argued. Despite these trends, however, the individual investigator did not disappear, but thrived.

In trying to understand why, Bejan believed that the constructal theory he began describing in 1996 provides clues. The theory is based on the principle that flow systems evolve to balance and minimize imperfections, reducing friction or other forms of resistance, so that the least amount of useful energy is lost. Examples in nature are the rivers and streams that make up a delta or the intricate airways of the lungs.

In the example of research, there appear to be two main flows: those of ideas in the form of scientific findings, and those of support, measured by tangible factors such as funding and laboratory space.

"Successful research groups are those that grow and evolve on their own over time," Bejan said. "For example, an individual comes up with a good idea, gets funding, and new group begins to form around that good idea. This creates a framework where many smaller groups contribute to the whole."

However, extremes at either end of the spectrum are not conducive to productive science, Bejan said.

"If an institution is made up only of solitary researchers, it would have many ideas but little support," he said. "On the other hand, a group that is large for the sake of size would have a lot of support, but would comparatively have fewer ideas per investigator."

Such an extreme example would be that of the old Soviet-style research, where the government decreed the goal and scope of research and populated its monolithic structures with like-minded scientists. The more efficient laboratory model would be one that grows naturally, without dictates from above, Bejan said.

For these reasons, Bejan said there is not an inherent conflict between research empires and the individual, but rather a balance that serves the greater good. Institutional administrators therefore should not worry about such conflicts since the structure follows a natural design as described by the constructal theory, he said.

"I would argue that those administrators who coerce their colleagues into large groups solely to attract more funding, to beef up their curriculum vitae or to generate more papers, are acting against the self-organizing

nature of the institution and its research," Bejan said. "Complete coalescence into large groups does not happen and will not happen."

Source: Duke University

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