Open Discussion on Hanaor's paper: Debunking "Tensegrity" - A Personal Perspective

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Tensegrity, the Queen of Structures?

Discussion about Hanaor's paper ("Debunking Tensegrity – A personal Perspective") on International Journal of Space Structures Vol. 27 No. 2&3 2012

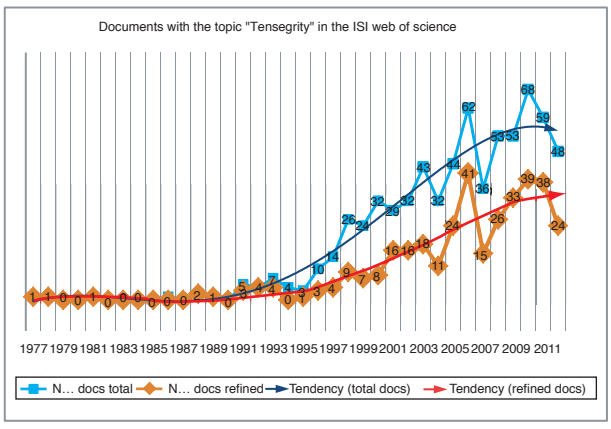
In the last issue of this journal, Arial Hanaor exposed some very interesting and inspiring (as well as controversial) thoughts about Tensegrity structures. I could not decline the invitation to participate in the discussion, in which I would really like to thank the Editor, Prof. Motro.

What is Tensegrity really? It is a pity that the term, coined by Fuller as a contraction of "TENSIonal intEGRITY" (and no "tensile integrity", as stated in the paper) has been degenerated and misused, losing its original meaning. An example is the patent for a "Female condom employing tensegrity principle", which could be anything except a tensegrity. As a consequence, it seems that now it is necessary to invent another word to exclude all those connotations that have been juxtaposed to the original one. It is true that 30 years ago there was no accurate definition about tensegrity, but the subject was properly limited and bounded. When Fuller, Snelson, Emmerich, Pugh, Kenner, Grip, Vilnay, Hanaor or Motro talked about tensegrity, they spoke the same language.

Although it is difficult to find a unified definition of Tensegrity, most authors would agree that they are different to some other typologies of cable-strut structures in an essential characteristic: they don't need any external support to be stable. If we exclude all the "continuous-tension discontinuous compression structures" that don't respect this condition, the amount of works, researches and documents concerned decreases dramatically. It would also be possible to talk about other characteristics, like having a tensed (and not compressed) boundary, non-touching struts, state of self-stress, etc. However, with the first one it is possible to eliminate all the cable domes that have claimed to be tensegrity structures since the 80's.

It would be contradictory to create a new term for a structural principle that already had its own. However, it would be great if everyone could call the original tensegrities in a unique manner, distinguishing them from other cable-strut structures that have been included in the same sack. The term "strut-tendon structure", proposed by Hanaor, would be a good option, although it does not imply the absence of external supports (as also happens with "floating compression", coined by Kenneth Snelson). In fact, if I had to propose a name for the "original tensegrity" concept, I would choose "Snelson structure", as almost all his sculptures express what we want to describe. I share Hanaor's thoughts now: "*I am under no illusion as to the chances for such an alternative terminology to replace the existing popular/populistic misterminology, or to compete with Fuller's ingenuity for coining catch-words*."

It is also interesting how Hanaor expresses in his paper the paradox about the interest that many researchers show for these structures lately, just when he convinced himself about their limited applications. Actually, the amount of documents published on the last 15 years about Tensegrity is in continuous progression. The following study was done on August 6, 2012: a simple search on the ISI Web of Science database (topic = tensegrity) gives 675 results. The tendency line (polynomial 4th degree) during the last years is shown in red in the following diagram:



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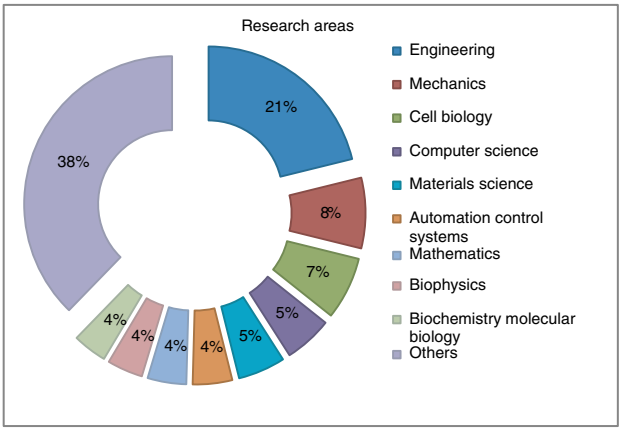

Although most of them are included in the areas of Engineering (275) or Mechanics (91), in that list of 675 records many of them are related to the so called Biotensegrity (e.g. Cell Biology 81, Biophysics 46, Biochemistry Molecular Biology 44). If those documents (and some others that have little or nothing to do with Tensegrity as a pure structural system, like Paleontology or Psychology) are excluded, the number of records is reduced to just 342. The tendency line in this case is not much different than in the other, which shows that the interest for the topic is common to all the categories of study.

From all those researches, unfortunately not all of them belong to "pure" tensegrity systems. Discarding the "false" cable-strut structures would be hard and tedious. However, even if they don't concern to proper "Snelson structures", they may help a lot for analyzing, applying and understanding the "real" tensegrities better. I personally agree with Hanaor when he mentions that there is the issue of research *per se*, that not all research has to have immediate applications.

Indeed, in the book "Godel, Escher, Bach-An Eternal Golden Braid", by D.R. Hofstadter, it is said that Number Theory is the Queen of Mathematics, the purest branch, because it is the only branch of mathematics which has no applications. In the same way, it could be said that Tensegrity is the Queen of Structures, the purest branch, because it is the only branch of structures which has no applications. It is not a coincidence that in both areas the number of applications is increasing slowly but firmly year after year.

In my opinion, even if applications for tensegrity systems (other than, deployable structures, "sculptural architecture" or biotensegrity) are very immature or utopic, there is always the hope that researchers will find proper and adapted applications for these particular structures with such peculiar performances. As is usually said, there is no such pure or fundamental research Vs applied research; there only exists applied research and research to be applied.

Finally, I have to acknowledge my admiration for Ariel Hanaor. Not only has his work been an inspiration and reference for many researchers, but also his honesty and professionalism should be a guide to scientists. It is admirable that somebody, after investing so many years in a research field, recognizes one day that he has arrived at the end of the road, finishing so honestly that chapter of his career. "Demonstrating a well-founded negative result is therefore often more valuable than confirming one's expectations or wishes". Even more, being one of the most influent persons in that area. Thanks for this lesson.

Whatever the case may be, I would like to evoke this thought by Ramón y Cajal, Nobel Prize in 1906: "There are no worn out questions, only men worn out in the asking. One wise man's desert may be another's fertile plain."

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