Wherefore Art Thou CFD?

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ABSTRACT

"O Romeo, Romeo! wherefore art thou Romeo?" This does not mean what it seems. According to [1], "This is one of Shakespeare's best known lines – from, of course, *Romeo and Juliet,* 1592. The 'wherefore' here means why rather than where. What Juliet is asking, in allusion to the feud between her Capulet family and Romeo's Montague clan, is '*Romeo, why are you a Montague?*'. Their love is impossible because of their family names and she asks him to change his allegiance, or else she will change hers." I created the title to my talk for a few different reasons. One was the location of the story, which was in Italy, and here we are. Another is, it suggests asking questions about the subject, in this case, CFD. That is what I want to do, but specifically about two subjects, variational multiscale and isogeometric methods. I want to review the state-of-the-art and recent developments in these areas, and speculate on the future. The final reason I chose the title is, I like it.

The variational multiscale method enables desired mathematical outcomes, such as optimal error estimates, to be rationally incorporated in the design of a CFD method, and provides a unified approach to the development of numerical methods and turbulence modeling. The variational multiscale method is now over twenty years old but continues to generate a large number of research studies every year and the footprint of applications continually expands. The question arises, is there still something fundamentally new in CFD that will emanate from within this approach?

The isogeometric approach utilizes trial functions emanating from computational geometry. They possess many advantages over traditional functions including precise and efficient geometric modeling; simplified mesh refinement strategies; high accuracy combined with robustness; smooth, compactly supported bases; exact point-wise satisfaction of incompressibility, accurate derivatives and stresses; preservation of important geometric structure (e.g., conservation laws, enstrophy, helicity), and the possibility of better integrating computer aided design and CFD. Isogeometric analysis is just over eleven years old, and has become the most active area of research in computational mechanics, especially computational structural mechanics, as well as computer aided geometric design. The question here is, with all the aforementioned advantages, why has isogeometric analysis not had similar rapid growth in CFD? One possible answer to this is the lack of volumetric spline-based modeling tools available. However, recent progress in this area is encouraging. Are there other reasons for the delay in more widespread adoption?

REFERENCES

[1] The Phrase Finder, http://www.phrases.org.uk/meanings/262200.html