General aspects suggested to be considered in review of SPH papers

This document presents a concise guidance regarding review of SPH papers. In general, SPH papers can be divided into three main categories:

1. Those presenting a theoretical analysis
2. Those presenting a new, enhanced or extended scheme/method/methodology
3. Those presenting a new industrial/engineering application

For the sake of brevity, throughout this document we use “analysis”, “scheme”, “application”, respectively referring to categories one to three mentioned above.

The below nine aspects and related questions are suggested to be considered in review of SPH papers:

1) Novelty:

- What is the exact novel contribution with respect to the state-of-the-art? a theoretical analysis? a new/enhanced method or methodology? a new/enhanced scheme? extension of a previously developed scheme? a new industrial/engineering application?
- Why is new research needed in this area?
- Is an appropriate (up-to-date, in-depth, and unbiased) literature review presented to properly assess the state-of-the-art?

2) Significance:

- How significant is the contribution with respect to the state-of-the-art?
- Does the new development/analysis address a long-lasting challenging issue in the field (e.g., concurrent enhancements in conservation and convergence features)?
- Does the new contribution take into account new physics that had not been rigorously/comprehensively considered before (e.g., turbulence, boundary layers, multi-scale multi-physics problems)?
- How are the results compared with respect to the state-of-the-art including other relevant and/or established computational methods?

3) Rigorousness:

- Are the mathematical/physical foundations of the new contribution well understandable and justifiable?
- Is the derivation procedure/analysis, including all the considered assumptions, thoroughly credible and reasonable?
- Is the new contribution coherently and comprehensively presented in terms of governing equations, boundary conditions, computational algorithms, discretisation schemes, etc.?

- If applicable, in terms of mathematical compatibility and physical consistency, is the scheme well justified? Is the scheme thermodynamically consistent? Is the scheme variationally consistent?
- If applicable, are simplifications physically sound and justified? (e.g., reproduction of 3D fluid flows by a 2D model)

4) Validity and Reliability:

- Is the conducted validation comprehensive and includes both qualitative and quantitative validations?
- Does the validation include acknowledgement of the published state-of-the-art including relevant comparisons?
- Does the quantitative validation include convincing error analyses and convergence rate investigation?
- For schemes/applications, do the qualitative and quantitative validations cover both kinematics (free-surface evolution, structural response, velocity field, vorticity field) and dynamics (pressure field, stress field)?
- Are the boundary conditions (e.g., dynamic free-surface boundary condition, fluid-structure interface boundary conditions) precisely imposed and satisfied in both continuous and discrete forms?
- Are the existing discrepancies with respect to the reference solutions well explained and justified?
- If applicable, is the scheme rigorously, systematically and comprehensively validated with respect to reliable reference solutions including exact theoretical and/or experimental ones?
- If applicable, is the scheme well validated in terms of conservation features (e.g., momentum, volume, energy)?
- If applicable, is the scheme well justified and convincingly validated in terms of considered fundamental assumptions that the scheme is built upon? e.g., principles of continuity, fluid incompressibility (In this regard, numerical resolution of the continuity equation can be presented, i.e., velocity divergence field and kernel-summation density field).

5) Computational Performance:

- Is the scheme computationally efficient? Are adequate justifications provided in terms of CPU time and memory requirement? Is the computational complexity well justified by the gain in accuracy?
- Is the scheme well justified and extendable with respect to computational adaptivity (e.g., multi-resolution simulations)?
- Is the computer program profiling well presented? (Especially for new hardware accelerated codes)
- Is the implementation of the computer program well presented?

6) Generality:

- Is the scheme generally applicable/extendable to reproduce all relevant and possible encountered physics? (e.g., problems characterised by tensile stress states or sudden temporal/spatial changes in the state of stress, high-Reynolds number flows, problems involving large topological changes, problems including material or kinematical discontinuities, phase change, etc.)
- Is the scheme generally applicable/extendable to reproduce relevant engineering applications with respect to advancements in technology (e.g., advanced materials)?
- Are the limitations of the scheme/analysis rationally and convincingly described?

7) Scrupulousness:

- Are all details corresponding to the scheme/application comprehensively and scrupulously given to ensure a perfect reproducibility by the readers? Such details include precise descriptions of computational conditions including initial/boundary conditions, material properties, utilised parameters or stabilisation schemes, time integration scheme, etc.

8) Clarity and Conciseness:

- Is the overall presentation of the scheme/analysis/application clear, cogent and comprehensible?
- Are all figures/tables presented clearly, precisely and informatively?
- Are all descriptions (corresponding to mathematics, physics, numerics, results) clear, concise and comprehensive?

9) Future Perspectives:

- What are the future perspectives for further development of the presented scheme/analysis?
- What kind of other challenges the new contribution can potentially address in its future development?
- Does the article portray a clear vision for the contribution of the presented new development to the societal challenges?