

CRITERIA FOR A GRAND CHALLENGE

as suggested by the UKCRC Grand Challenges Working Party
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Revised by Tony Hoare, 30 May 2002.

The primary purpose of the formulation and promulgation of a grand challenge is to accelerate the advancement of science. The only purpose of this document is to clarify the concept of grandness as applied to a scientific challenge. The suggested criteria concentrate on those aspects of grandness that contribute towards the primary scientific goal of the challenge. They are the criteria that distinguish a grand challenge from the many other worthy kinds of challenge that are formulated to contribute to economic, political or other societal goals.

Each criterion is intended to describe some property relevant for the comparison and evaluation of proposed grand challenges **solely** according to their degree of grandeur. **No challenge, however grand or otherwise desirable, should be expected to meet all the criteria. The order of the criteria is not significant.**

1. It arises from scientific curiosity about the foundation, the nature or the limits of the scientific discipline.
2. It has enthusiastic support from (almost) the entire research community, even those who do not participate.
3. It has international scope: participation would increase the research profile of a nation.
4. It is generally comprehensible, and captures the imagination of the general public, as well as the esteem of scientists in other disciplines.
5. It was formulated long ago, and still stands.
6. It goes beyond what is initially possible, and requires development of techniques and tools unknown at the start of the project.
7. It calls for planned co-operation among **identified** research teams and schools.
8. It encourages and benefits from competition among **identified** individuals and teams, with clear criteria on who is winning, or has won.
9. It necessitates collaboration of several **identified** research specialities, theoretical and/or practical.
10. It decomposes into **identified** intermediate research goals, whose achievement brings scientific or economic benefit, even if the project as a whole fails.
11. It should be rather obvious how far and when the challenge has been met (or not).
12. It should lead to radical paradigm shift, breaking free from the dead hand of legacy.
13. It is not likely to be met simply from commercially motivated evolutionary advance.

The word 'challenge' is these days commonly applied to a survey of relevant topics in some general research area that promises some short-term social or economic benefit, often just to a single nation or region (provided, of course, that sufficient research funds are allocated to it immediately). **The criteria listed above are not intended to apply to such challenges.**

The tradition of Grand Challenges is common in many branches of Science. If you want to know whether a challenge is grand enough, compare it with:

- Put a man on the moon
- Cure cancer (in ten years)
- Prove Fermat's last theorem
- Map the Human Genome
- Map the Human Proteome
- Find the Higgs boson
- Find Gravity waves
- Unify the four forces of Physics
- Complete Hilbert's programme for the foundations of mathematics

Some of these have succeeded, some of them have failed, and some of them are still open.

In computing, the following are listed, **not because we recommend them**, but because they are familiar to Computer Scientists. The reader is invited to evaluate any of the examples according to the criteria given later. **Obviously, no challenge will meet all of them.**

- Prove that P is not equal to NP
- The Turing test
- The Verifying Compiler
- A championship chess program
- A championship GO program
- Automatic translation of scientific literature from Russian to English.
- A mathematical model of the evolution of the web.
- A wearable computer serving as a guide dog for the blind.

Some of these have succeeded, some of them have failed; some of them have lost the interest of the scientific community, and some are reliably conjectured to be impossible. They are quoted here only as illustrations of the property of grandeur. **There is no implication that any of these will be found worthy of general support.**