Potential issues on applicability of laboratory test data for space systems safety

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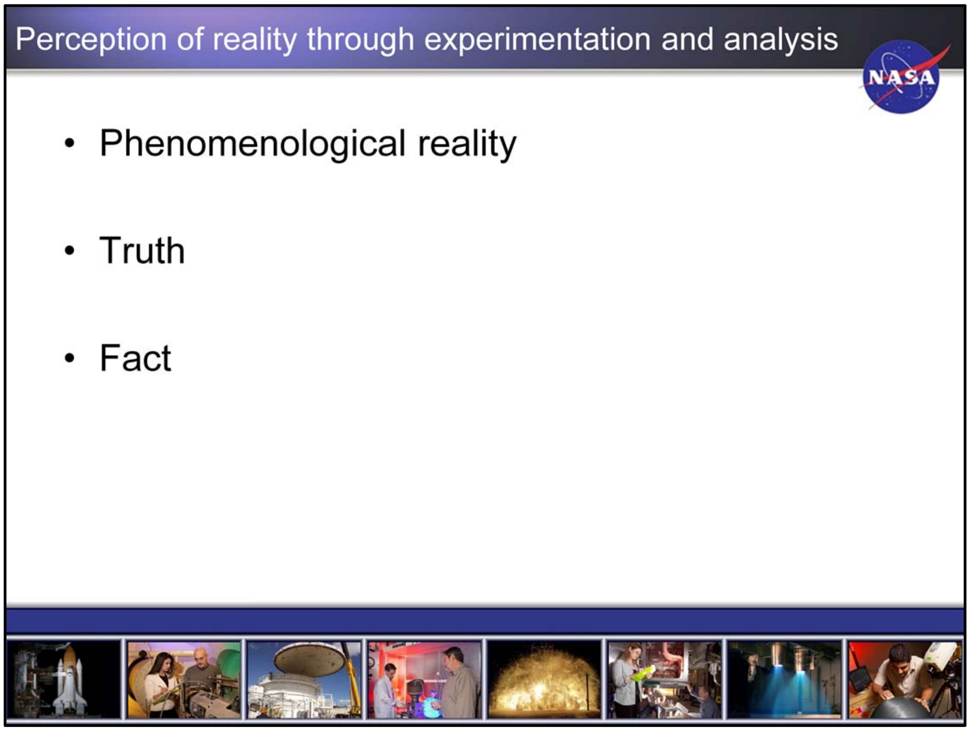
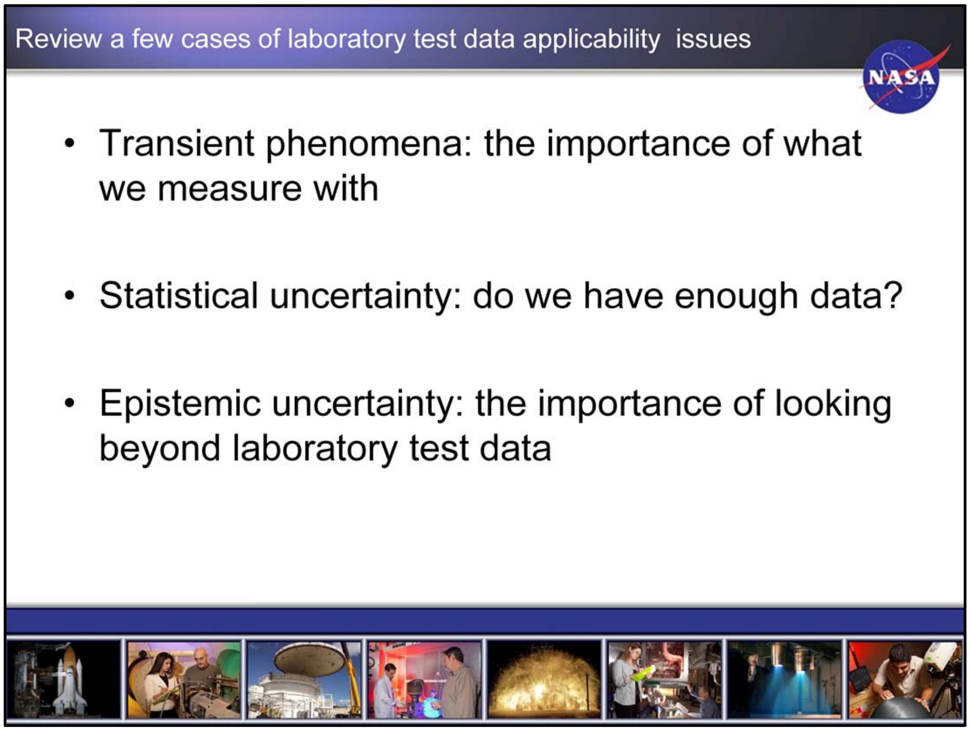
ISO SC14 Space Systems and Operations Plenary Meeting
Tokyo, Japan
May 26-30, 2014

Agenda

- Perception of reality through experimentation and analysis
- Review a few cases of laboratory test data applicability issues: Statistical and epistemic uncertainties as sources of bias on perceiving reality
- Examples

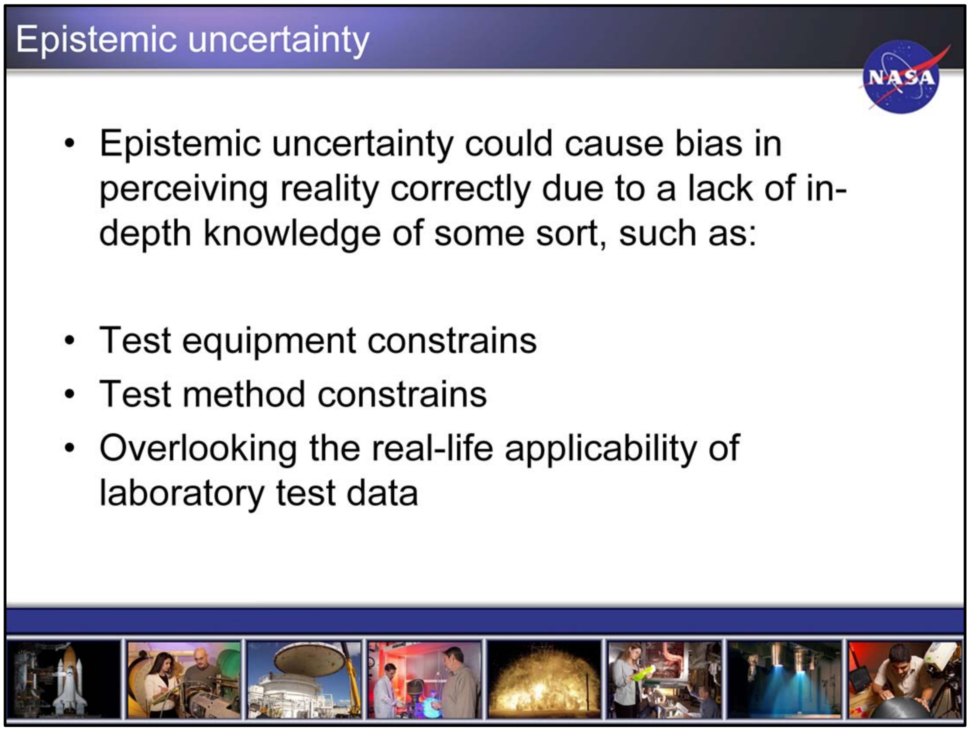


Reality means :the state of things as they actually exist". Private experiences, inquiry and selectivity involved in personal interpretation of an event shapes reality as seen by one and only one individual, and hence is called "phenomenological".
According to postmodernism, **truth** is subjective. It occurs when two or more individuals agree upon the interpretation and experience of a particular event. The commonality could become "truth" as seen and agreed upon by a certain set of people; this could let groups of people having extremely different notions on reality and truth.
A fact rarely could be subject to personal interpretation. The proposition "At Earth's orbital levels its gravity is less than on the ground" is a fact. Much of scientific experimentation and analysis is done at this level. With the assumption that there is a reality independent of any beliefs and perceptions, the scientific method can verify that a statement is true based on observable evidence, In the materials testing world the question which rises is "**do we have enough information from our test results to draw correct decisions for real applications? Are we with laboratory test data at an adequate level of perceiving reality correctly?"**



Selection of **proper measurement tools** could make the difference between realizing facts or settling with incorrect perceptions of reality. An example is a transient temperature measurement. The igniter used for flammability testing per ISO 14624-1 1nd -2 burns for approximately 25 seconds. During this time its temperature peaks, and than recedes. The peak temperature reading will be affected by the size of thermocouple used; it is likely that a thermocouple with a smaller thermal mass would respond faster and read higher. Specifying appropriate instrumentation and measurement methods in ISO standards is relevant to all situations, and more so for characterizing transient phenomena. In the example presented, we look for two major things: to know the real temperature (with a thermocouple we could come *as close as possible only* as close as possible, since the device perturbs the real system) and achieve consistency among laboratories.

Statistical uncertainty from insufficient amount of data may lead to biased perceptions of reality. Perhaps at first, this issue should be realized and appropriate confidence statements should be considered as part of data analysis report. Secondly, the more challenging issue could arise with the realization of the inadequacy of the amount of data which can be taken due to practical constrains. Such an issue could arise for example on obtaining flammability experimental data in spacecraft; in this instance more sophisticated methods may have to be used. Perhaps inverse modeling to optimize the parameters of the ground-to space environment correlations could be employed. Inverse modeling is used in geophysics on inferring information on Earth's interior from physical surface measurements See Mosegaard and Tarantola, Monte Carlo Sampling of Solutions in Inverse Problems, Journal of Geophysical Research, Vol. 100, No. B7, 1995, pp 12431-12447) . This application is not unlike inferring spacecraft materials flammability mostly from 1-g data.



Examples

Test equipment constrains: Flash point testing - there are instances of fluids that require large diameter for flame propagation; they may not have a flash point in a standardized test equipment. However, their vapors may be flammable and will burn when ignited in a larger volume.

Test method constrains: Limiting oxygen testing: During oxygen hazards analysis, polymer flammability is commonly assessed by ISOxxxxx. However, the data provided may not accurately predict materials performance in many real-life applications. For most materials, the LOI is significantly reduced when the test is conducted with upward flame propagation and/or external heating. This would render some materials flammable in real-life, although they would be predicted as self-extinguishing by the laboratory test.

The need for knowing the real-life applicability of laboratory test data: Forecasting materials behavior in spacecraft environments from ground test data. An example is qualifying materials for spacecraft following ISO 14624-1 and -2 without confirming laboratory data applicability for spacecraft environments. Materials qualified by the test may turn to be flammable in forced-convective microgravity environments typical encountered in spacecraft. The pass/fail test logic of the methods do not allow quantitative correlations. An alternate method proposed relies on evaluating flammability extinguishment limits (one approach for ground testing is presented by ISO TS 16697). Preliminary data indicate that the ground laboratory test data may not be always conservative.

Discussion

- Laboratory test data for space systems and operations safety should be analyzed with real-life applicability in mind

- Potential limitations should be noted within the body of test method standards