The Regulation of Technological Innovation: The Special Problem of Fire Safety Standards

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Code of Hammurabi

If a builder has built a house for a man, and has not made his work sound, and the house he built has fallen, and caused the death of its owner, that builder shall be put to death

Safety versus Trade

Regulators all over the world are trying to balance innovation and fire safety.

Under pressure from economists who wish to reduce barriers to trade, regulators routinely rely on safety testing to certify products for worldwide shipment

Safety

Safety can often be analogized to a bicycle lock. To bicycle designers, locks are distinctly secondary to performance. Locks do not help the designer satisfy primary customer requirements Locks do not make bicycles faster, lighter or easier to use. Bicycle locks simply make sure the bicycle will be there the next day

PROBLEM OF REGULATING "INNOVATION"

Technical regulation tends to work most effectively in areas that are technologically stable. Regulators build up experience and understand the problems with a regulation.

Most testing derives from the history of quality control, where tests were developed in an environment of technical and social stability

Can you "test" your way to safety

Since suits of armor were *proved* by shooting standard bullets at them

People have tried to develop tests that will clearly establish whether specified levels of safety are reached.

Mt Blanc

. At Mt Blanc in 1999, 39 people were killed in a massive fire which originated in a truck carrying margarine and flour. Some investigators and public officials expressed surprise that margarine could cause such an intense fire. After all, the regulations treat such material as ***Low hazard***

Both tunnel designers and regulators shared a lethal confusion on the issue of what might be called "*ignitability*" versus *flammability* of the relevant materials.

Ignitability

"ease of ignition'. This is the tendency of a specific object to ignite easily when exposed to a flame.

Flammability

Alternatively, the effective heat of combustion or Caloric potential is the contribution of the material as fuel to a fully developed fire in terms of BTU/pound or kilojoules per kilogram.

Wood shavings and solid wood have similar ***flammability*** but shavings are far more ***ignitable***.

The difference between *ignitability* and *flammability* is therefore critical to safety and the regulatory process; but typical 'performance standards' routinely do not indicate which attributes they are using.

Margarine Truck 900 GJ

The caloric potential of trucks can vary widely, according to their cargos. Therefore,

some cargos, not classified as hazardous in the strict sense of the rules, generate when burning caloric potentials close to those of inflammable liquids (classified as hazardous cargo). This is especially the case with …. The caloric potential….. To about 900 GJ (all margarine cargo) (Task Force, 1999).

CONFUSING "CAUSE OF THE IGNITION" WITH THE "CAUSE OF THE DISASTER"

For legal, political, financial, and public relations reasons the source of the "ignition" is often pinpointed as the ***cause*** of the disaster.

From a fire safety design perspective the ignition is rarely the *cause* of the overall disaster. Ignition is simply the initiating event. The disaster occurs because the event cannot be controlled

Hindenburg

- After a disaster, blaming the ignition source for the ultimate catastrophe is normally an attempt to divert attention from the failure to plan effectively for a spreading fire.
- As a rule, preventing ignition in uncontrolled environments is normally impossible, so fire safety systems have to be robust enough to absorb an ignition without catastrophe.
- Fire safety regulation has to be built on the concept of containing the possible ignitions before a disaster ensues

DISAGGREGATED REGULATION OF COMPLEX INTEGRATED PROBLEMS

The ASTM E119 test does not capture critical behavior of structural systems, e.g. the effect of thermal expansion or sagging of floor beams or girders connections and/or columns. The thermal expansion of the WTC 7 floor beams that initiated the probable collapse sequence occurred at temperatures below approximately 400 degrees C. Thus to the extent that thermal expansion rather than loss of structural strength, precipitates and unsafe condition, thermal expansion effects need to be evaluated. The current fire resistance rating system, which does not include Thermal expansion effects, is not conservative 4.5.3 (NIST WTC REPORT 2008)

Regulating innovative technology

Regulators are trying to decide whether to allow bicycles in traffic

What do you think of when you think of bicycles?

Bicycle

But what's this ?

Innovation

The recumbent bicycle is “technically” a bicycle, but it represent a totally different road hazard

The rider can no longer see or be seen

Innovation Risk

Innovation risk describes the ability to create a product that meets the technical requirement of a regulation or test but represents a novel hazard.

Innovation risk exists in any type of performance testing.

Innovation

Innovation poses the greatest challenge to any test based regulatory system since the ability to create a new product is not always connected with the ability to understand its risks and therefore to develop an appropriate test.

You may not even know you have a problem since the effect of the innovation may not be clear

Innovation

The normal answer to innovation risk is to have a regulator with adequate discretion and expertise examine each innovative product or situation to determine whether the regulatory test is adequate to describe the risk arising from the new product

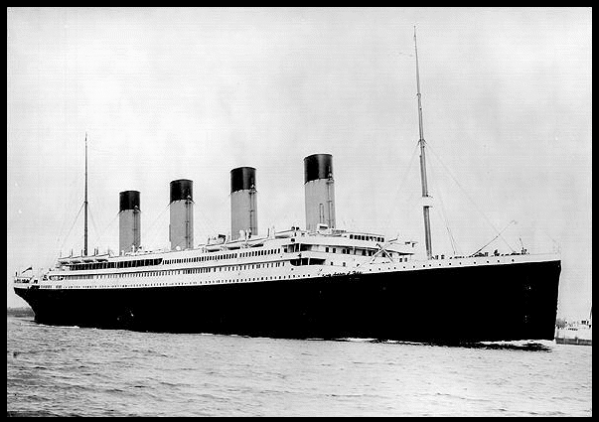
This is not easy

Titanic Syndrome

From the time of the RMS TITANIC it has been known that reliance on inadequate regulations to control innovation can produce a disaster, but no systematic response has been generated analyzing the relationship among designers, test developers and regulators.

Titanic Syndrome

1. ***Titanic*** Defense
2. ***Titanic*** Response



THE TITANIC DEFENSE

After every major disaster the responsible parties normally proclaim the *TITANIC* defense of "***We complied with all government regulations".*** While some of these responsible parties may be charlatans who knew all along that the regulations were inadequate for the hazard, others may be genuinely surprised when regulatory compliance does not generate safety.

Titanic response

Do as little as possible and address only the precise failure, not the root cause

COMFORTABLE ASSUMPTIONS

Producers often make the *comfortable assumption* that legal compliance is sufficient for technical safety.

These assumptions are often made without the slightest analysis of the regulatory system

Creating Regulatory Tests

1)Defining the Technological Frame
2) Creating the Technological Model
3) Developing the Test Method
4) Validation Verification and avoiding Reification

1) Defining the “technological frame”

The first step is defining the ***technological frame*** for regulation. The technological frame describes the problem that people think they are dealing with in creating a regulation

e.g. High rise building fires conjures up a “technological frame”.

Technological Frame

The scope of the technological frame is critical. Arson and terrorism for example were not routinely part of the technological frame for high rise buildings prior to 9/11. Because frames are described in natural language by individuals of varying backgrounds they are always difficult to define in a rigorous way

2) Creating the Technological Model

A regulatory “technological model” is a derivation based on one or more technological frames that defines the specific scientific and engineering data, principles and assumptions thought to be relevant to controlling the technology.

Technological model

At Mt Blanc the concentration on *ignitability* rather than *flammability* for the definition of dangerous goods in tunnels is an example of a model.

The technological model of the SBI, such as it has been documented, is essentially based the room corner test as a reasonably full size mock up of the real world. It is therefore a “model of a model”

Technological Model

Including or excluding a characteristic in a technological model for regulation is often a process of concurrence by interested parties rather than rigorous analysis. Since the models are rarely published or preserved, it is often difficult to analyze the thought process or possible errors in the process.

Developing the Test Method

The variables identified in the model building process are then further refined and abstracted to create the regulatory test itself.

Normally only a small subset of the real world variables is used in the test

Developing the test method

At this stage of development regulatory or "forensic" concerns begin to dominate the process of test development. Regulatory tests often give clear cut discrete outputs even if the underlying reality is a continuum.

Bright lining

Creating and relying on inappropriate dividing lines or classifications

bright lining can contribute to a false sense of security. The real difference between a bare pass and a clear pass may not be captured in the test

Validation and Verification of Regulatory Tests

Verification means that the test actually properly classifies the variable it is assumed to test. Verification is a necessary but not sufficient condition for a test.

Validation establishes that the variables being tested are actually relevant to the safety hazard.

Validation is by far the more difficult task and must be conducted continuously over the lifetime of the test or standard.

Validation and Verification

Validation and Verification of fire tests are separate activities For verification the test has to be demonstrated to be a robust method of measuring a true variable.

Repeatability of a test is a necessary but insufficient criteria for use in regulation.

Validation requires demonstration of the accuracy of the variable in addressing the real world problem it is designed to solve.

Avoid Reification of test results

Reification is the inappropriate treatment of the output of a test as a description of the properties of the object in the real world.

The ***Reification*** fallacy is believing the test scores describe an inherent ***attribute*** of the material and the test is simply a ***measure*** of that attribute, rather than the test score is a joint product of the test method and sample which may or may not reflect an actual ***attribute*** of the material.

Reification

For example if the SBI is described as testing the *fire resistance* or *flame resistance or even reaction to fire* of a product or material the test result is being ***reified***.

The statement assumes that such a attribute exists separate from the test and the test is just measuring it. For example an industry publication claims:

Reification

"The fire resistance of construction products according to the new Euroclasses

was assessed with a SBI (Single Burning Item) test. Finnish Thermowood Association Handbook"

SBI

The Single Burning Item is a method of test for determining the reaction to fire behaviour of building products (excluding floorings) when exposed to the thermal attack by a single burning item (a sand-box burner supplied with propane). See website athttp://ec.europa.eu/enterprise/construction/internal/essreq/fire/frg/sbianounc.htm

Avoid reification

The SBI classifies, it does not even claim to "measure". It is a regulatory result which cannot, without further analysis, be used in an engineering or technical analysis, or to claim that a product is safe or a combination of such products will produce safety.

Avoid Reification

The practical hazard of reification in the real world is the blind reliance by non specialists on ratings obtained in a specific test designed for a specific purpose.

Reification can cause a disaster in a regulatory environment where designers merely rely on test results rather than having those test results evaluated by people with both expertise and discretion to control the inappropriate use of the test.

Losing track of the frame or model

The most common problem is simply that the frame and model are simply forgotten after the test method is created. The SBI for example contains little documentation of the rationale for the choice of burner size that would allow a regulator or designer to determine if results on the SBI are relevant to a variety of environments. In particular, what is the relevance to an exposure fire?

Inappropriate Treatment of Innovation

The inappropriateness of an existing reference scenario has to be demonstrated and an alternative proposed. The fire hazard condition and its relevance shall also be indicated, together with a suitable large scale test that can be shown to be representative of the proposed new hazard scenario." (SBI Guidance)

Conclusion

Public safety in the single market requires designers and operators to take on and be fully responsible for the safe design of their buildings. They can not pretend that compliance with the CPD will automatically produce safe buildings

Thank you

Special thanks to Jim Quintiere