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Is it possible to quantify the social perception of an industrial accident risks? Lesson from the Mont Blanc highway tunnel fire tragedy.

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1. Case Study Introduction

The Mont Blanc Tunnel was completed in 1965 and used for 34 years before a tragic accident, vividly echoed in international media, brought long lasting socio-political consequences throughout Europe.

On the morning of 24 March 1999, 39 people died when a Belgian transport truck carrying flour and margarine caught fire. Several kilometres into the tunnel, the driver realized something was wrong, as cars coming in the opposite direction flashed their headlights at him; a glance in his rear-view mirrors showed white smoke coming out from under his cab. He stopped, fire was not controlled, thick smoke developed, drivers got disoriented and chocked, and the tragedy was consumed.

Previously there had been 16 other truck fires in the tunnel, always extinguished on the spot by the drivers. The heavy truck traffic was estimated at 8.77 Mkm/yr (million kilometres per year).

Reportedly, there were no risk assessments performed on long tunnels (risk assessment became a legal requirement in the post-accident era). People saw long series of "near-misses" developing and came to believe that they were "a fact of life", in a pattern we have unfortunately seen developing over and over in many industries[1].

This paper discusses:

- how a risk assessment could have been carried out before the accident,
- if the risk would have been considered societally acceptable (obviously it was not, as the socio-political consequences demonstrated).

1 http://www.riskope.com/2012/09/05/close-calls-and-human-biases/

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2. Framing Probabilities & Consequences

The discussion requires framing the likelihood of occurrence and the magnitude of consequences: we will first consider the case where the fire would have been caused by a "standard" traffic accident (head-on collision), then we will consider on-board fires.

2.1 Classic road accident

The probability to see an accident in the Mont Blanc tunnel leading to loss of life would most likely be associated to a catastrophic "standard" traffic accident.

Based on road accidents statistics, for 1Bkm there would be 2.5 onboard truck casualties, i.e. 0.022 victims/yr.

The same analysis performed "against the truck" would lead to a ten times larger figure, 0.22 victims/yr. We will note that this number seems rather unreasonably high for a tunnel where passing is forbidden, and speed is controlled. Thus, we will consider this as an extreme upper bound of the probability of one casualty. Remember, it is always better to use ranges rather than arbitrarily censoring results: at least you are honest and you admit what you know you do not exactly know.

2.2 Fire related road accident

Another way of framing probabilities and related risks would have been to consider the 16 actual fires events in 34 years, which could be considered near misses of a major fire, as they produced no casualties. These numbers yield an estimate of 35% for the probability to see one or more accidents within next year. Remember we are setting ourselves at a time before the accident.

2.3 Consequences

With the knowledge of the times (i.e. pre-catastrophic fire and prior to the resulting understanding of the "secondary effects" of forced ventilation, probably no one would have assumed the possible horrible tally of 39 victims. As a matter of fact, prior "good luck" and human tendency to bias and censor risk evaluations would have helped biasing the assessment in the direction of lesser casualties, assuming a small number of victims and avoiding the "unthinkable scenario", had anyone actually bothered to perform a risk assessment[2].

However, considering the actual frequency of fires was so significant (16/34), we like to believe that a worst case scenario would have been contemplated. In a possible

2http://www.riskope.com/2012/02/22/our-judgements-are-clouded-by-prejudices-and-misconceptions/

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fire-driven loss of control and subsequent head-on with a light vehicle, 5 victims could have easily be assumed, 15-20 in case of a head-on with a van or bus.

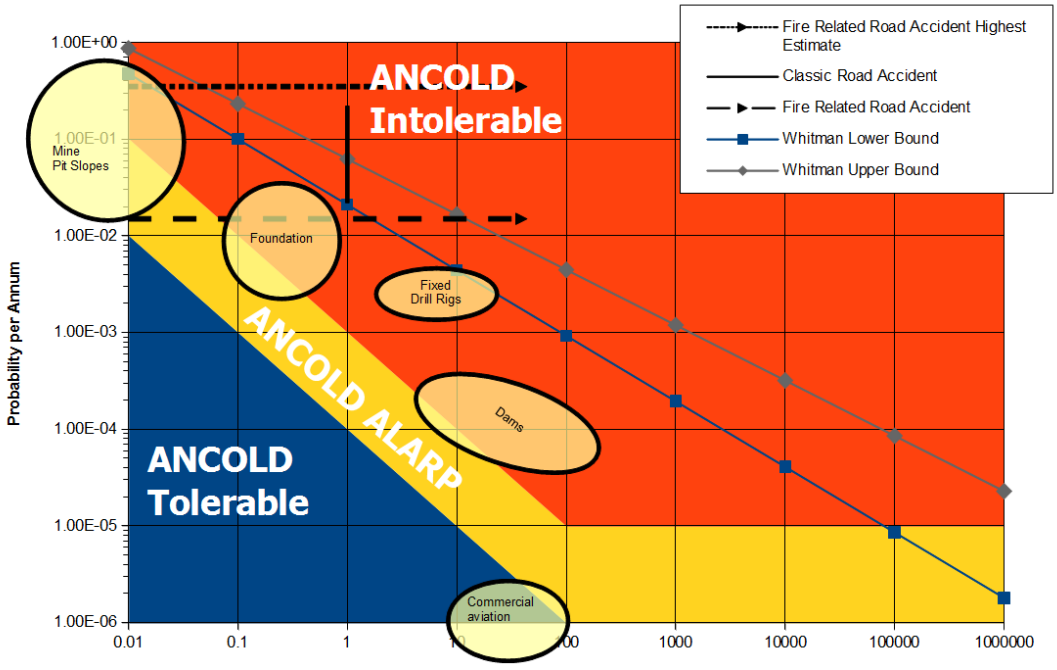
The 16/34 frequency is certainly too high as these occurrences were near-misses with no casualties.

Frank's principle can be applied to evaluate a more realistic probability, despite it's well known limitations. The near misses brought property damage (truck caught fire and tunnel was slightly damaged by smoke and temperature). Frank's pyramid gives a ratio of 30 such accidents to 1 serious accident. As there had been a series of 16 near misses in 34 years, the probability of 1 serious accidents, based on Frank's pyramid can be evaluated at p=1.5%, respectively 0.01% to see 2, in the coming year.

3. Risk at the Mont Blanc Tunnel

3.1 Societal Tolerability

The values derived above can now be plotted on a p-C graph also displaying societal tolerability levels developed by Whitman[3].



3http://foboni.wordpress.com/2011/09/06/what-fukushima-2010-nuclear-accident-the-twin-towers-911-terror-attack-deadly-traffic-accidents-and-aquila-earthquake-italy-hurricanes-have-in-common/

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Within the ranges of annual probabilities evaluated above, most accident scenarios would be societally unacceptable.

A *a priori* risk assessment would have concluded that the risk was intolerable and mitigative measures would have been proposed. Unfortunately, apparently, no one followed this procedure before the accident and we can wonder if anyone would have followed this type of recommendations before the accident occurred, because there is a perception difference between societal consequences and factual consequences.

3.2 Societal vs. "factual" consequences.

The Mont Blanc accident consequences were tragic and complex: 39 casualties, structural damages to the tunnel itself, legal costs and liabilities, and a very long and costly business interruption which impacted an area with a radius of over 300km in central Europe from a traffic congestion point of view.

In the aftermath of the accident significant changes in the Safety Codes for tunnels in the European Union were introduced, which imposed analysis and additional infrastructural works to tunnel owners.

If a risk assessment would have been performed *a priori*, a strictly "facts driven" tunnel manager could have argued that the accident was not under his responsibility as far as traffic signals etc. were all code compliant. Therefore the cost "for the tunnel" would sum-up to factual consequences, i.e. removing the damaged vehicles, road surface clean-up, replacing a couple sign posts, and a few hours business interruption. All the rest would not be under "the tunnel" responsibility. Total cost estimate would have been very low.

A "societal" approach would instead have assumed 20 casualties as maximum consequence as discussed above, applying a WTP (societal Willingness To Pay to save a life developed by numerous authors around the globe[4]) of 3M€. An estimated loss of 60M€ could have been brought forward.

It becomes obvious that the selection of the type of consequences can severely bias the results. Consequences should be evaluated from an holistic point of view and a complex metric should be developed[5].

4 http://www.riskope.com/2009/09/30/long-term-risk-mitigation-plans-at-country-wide-scale-can-be-measured/
5 http://reviewboard.ca/upload/project_document/EA0809-001_Giant_Report_of_Environmental_Assessment_June_20_2013.PDF

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4. What is the solution?

The procedure the Authors propose encompasses the development of:

a) a holistic consequence function.
b) crisis cost multipliers to facilitate clients' decisions related to public reactions.
c) a communication plan to the client.

The communication plan would explain to the "fact driven" owner: "*look, we do understand your reluctance to use the societal consequence value* (for the reasons developed above)*, but, close your eyes and think a second to the first page on "tomorrow newspapers": TRAGIC FIRE AT MONT BLANC TUNNEL KILLS* ....pick a number". *Does the newspaper say it was a "standard" road accident? Does it say that it is not your problem? Will you have time to file a petition saying that it's an unfortunate problem, but you are not interested? Will you be in trouble then?*
YES, YOU WILL.
How much in trouble?
Based on other cases were fire killed people in Hotels, closed public or private spaces, in areas were the owner was responsible for fire extinction (a tunnel is very different from a open air highway in that respect), we would say quite significantly."

The proposed "crisis cost multiplier" for this case would probably range between 5 and 10 (based on prior cases experience). However, it does not really matter for the Mont Blanc, because even with a very small multiplier the risk would have been above the Whithman societal acceptability thresholds.

5. Conclusions

Perception of risks related to industrial accidents can be severely biased if consequences are censored and skewed either because the risk assessment method is too simplistic (PIGs), or if the analyst or the client decide to apply too strict "facts driven" approach.

Yet, numerous recent examples ranging from Mont Blanc tunnel to Fukushima, Lac Megantic RR accident, etc. have shown that the "fact driven" consequences evaluations approach will lead its user to unsustainable stances.

After showing that it is possible to "quantify social perception" and include it in a rational risk assessment framework, this paper suggests a communication strategy to be implemented when discussing with rigidly "fact driven" parties.