Working draft – under development

A review of the history of safety

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Introduction

This paper has been written to give a background to the emergence of leading-edge safety practice to help identify the methods that should be applied to the climate issue.

An adaptation-only strategy is not viable

The threat posed by climate change is well established scientifically and the detailed understanding of the world climate system is growing rapidly as each year passes.[3] It has also been credibly argued, by Nicholas Stern[4], that, *in the absence of corrective action,* the threats posed by climate change to the wellbeing of

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[1] RSTI – Research and Strategy for Transition Initiation

[2] Original: 9 February 2012

[3] See for example the detailed reports of much of the scientific literature in the 4th Assessment Report of Intergovernmental Panel on Climate Change and a useful summary by the Australian Academy of Science.
http://www.ipcc.ch/publications_and_data/publications_and_data_reports.shtml
http://www.science.org.au/policy/climatechange.html

[4] A special adviser to the UK government on climate change.

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people, the economy and non-human life across the globe is likely to be worse than a Great Depression or a non-nuclear World War[5].

So a response based *solely on adaptation* (with no effort made to control the problem) is not viable. Some level of control over the human causes of climate change must be attempted. And indeed all of the large greenhouse gas emitting countries in the world, both developed and developing, have been able to agree on at least this much[6].

Given this, what should our approach to the reduction of climate threats or climate impacts be?

Basic choices?

There are two fundamentally different approaches that can be taken to frame a threat-reduction strategy. One is to accept considerable change to the climate system but to try to bring the change to a halt before triggering unacceptably dangerous impacts on people, the economy and ecosystems. In other words the aim is to keep some 'distance' from serious conditions but otherwise to tolerate substantial changes to the environment. Taking this approach raises the question: how dangerous a climate are we prepared to risk?

The other basic option is to take a precautionary approach and, where the climate has been perturbed, to take steps to return it, in a timely way, to conditions known to be optimal. But what is optimal? All climates have dangerous weather, eg. extreme weather events, droughts, etc., that are dangerous or disadvantageous for *particular* people or other living things. An optimal climate is one that can support, that is, be safe for all species of life and human civilisation. This alternative approach raises the question: how can we move to, and then stay within, a set of safe climate conditions?

Our choice then seems to be between:
- avoiding dangerous climate change but accepting a substantial change to the climate compared to the preindustrial conditions, or
- restoring and maintaining a safe climate.

So how do we decide which option is best? To gain some perspective on this question, it is worth looking at the history of the industrial safety movement[7].

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[5] Stern, N. (2007). The economics of climate change: The Stern Review. Cambridge University Press: Cambridge. and the proceeding s of the UK 4 degree Conference
http://www.eci.ox.ac.uk/4degrees/programme.php
[6] At the Durban climate negotiations in December 2011
[7] Aldrich, M. "History of Workplace Safety in the United States, 1880-1970". EH.Net Encyclopedia, edited by Robert Whaples. August 14, 2001. URL
http://eh.net/encyclopedia/article/aldrich.safety.workplace.us
See also: Aldrich, M. (1997). Safety First: Technology, Labor, and Business in the Building of American Work Safety, 1870-1939. Johns Hopkins University Press.

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The evolution of safety management

Across the globe, human society has had about 250 years experience of accident management since the beginning of industrialisation. The broad pattern of evolution of the safety system seems to be as follows[8]:

- *a-Small diffuse beginnings*: initially experience of or awareness of serious accidents and disasters motivated a relatively small number of employees, business owners and community activists to take action. As it spread and intensified, industrialisation increased the risk of accidents to the point where they entered the psyche as a serious concern along with the risks arising from disease and war;

- *b-Public exposure was important*: media coverage (newspapers only in the earlier years) was important in raising awareness and preventing the issue of accidents being swept under the carpet;

- *c-One by one, governments dipped their toes into the water*: accident reporting requirements and inspection systems were introduced to ascertain conditions, inform the development of regulations and to assess compliance. Early mover governments provided models for others;

- *d-People began to aspire to safety as a new norm*: Once workplace safety laws were introduced some people in the regulated sectors began to consider the possibility that safe conditions could be a norm.

- *e-Mobilised labour generated significant pressure*: the growth of unionism and political radicalism, significantly increased pressure to act on safety;

- *f-Conservative Germany reformed to hold support, but as a result raised the bar*: Germany under the conservative reformer Bismarck, from 1884 began to use welfare state legislation (health, accident, old age and disability insurance) to win political support away from the socialists and to use the benefits of the social wage to retain young workers who might otherwise have migrated to the US where wages were higher but conditions were worse[9]. The German actions provided an example to other countries and helped to some extent to establish a bidding-war over safety[10],

- *g-Managers advocated 'Safety First' to shape <u>employee</u> behaviour*: one of the earliest slogans of the safety movement was "safety first" picked up in 1910 and popularised by the managements of US railway companies.

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8 MacLaury, J. (undated). <u>Government Regulation of Workers' Safety and Health, 1877-1917</u>. US Department of Labor (website).
And see Aldrich references as well.
http://www.dol.gov/oasam/programs/history/mono-regsafeintrotoc.htm
[9] Bismarck's reforms turned Germany into the first modern welfare stare.
[10] http://en.wikipedia.org/wiki/Otto_von_Bismarck#Bismarck.27s_social_legislation

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The role of the slogan at the time was to indicate that ensuring safety should be the first priority - for *employees*[11]. For the bulk of the period of industrialisation, it was generally held that employees were responsible for accidents unless employers could be proven to be negligent or malicious (and courts tended to be biased in favour of the employer);

- ***h-Incentives for most managements were not yet strong enough***: effective action on safety, within firms, needed top management to take on responsibility and to drive a systematic response throughout the organisation – because most individuals in a firm have little control over equipment/site layout, operational systems or culture which are in fact the major determinants of safety outcomes. But in the absence of strong and comprehensive government regulation and systematic financial costs related to accident rates, only a small number of firm managements chose to engage;

- ***i-Governments internalised the cost of safety for managements, widespread engagement followed***: once government regulation was in place - to set standards, introduce employer-paid 'no fault' workers compensation schemes that gave the absence of safety an unavoidable and relatively predictable cost - the majority of firms began to engage with the safety issue, with the larger firms often taking the most effective action;

- ***j- Once everyone was doing it, it wasn't so bad (level playing field):*** Prior to the introduction of new safety standards there was often considerable resistance from management because they felt that their freedom of action was being curtailed, or costs or technical difficulties were being added. However, it was generally the case that after regulations were put in place they were quite widely accepted. If all firms were subject to the regulations then the competitive impacts of safety requirements were limited. And often the total net cost of safety regulations was very modest, because of the cost savings gained as workplaces became safer.

- ***k-As firms went up the learning curve, down came the costs:*** As workforces gained experience in implementing safety practices, providers of products and services began to build in more and more effective safety features and managements took on more responsibility for safety the direct cost of safety began to fall. The classic learning curve benefits applied to safety as much as anything else.

- ***l-As society got richer, the costs of safety became a given of civilisation***: Since safety improvement in industrial society has been a 250 year process, it took place within a context where incomes were rising. This meant that safety became more and more affordable regardless of its absolute cost.

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[11] The slogan was invented by Thomas Lynch, General Manager of H.C. Frick Coke Company as part of a program to boost safety after the disastrous explosion in January 1891 at the company's Mammoth Mine that killed 109 miners.

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- ***m-From minimisation to systematic prevention, driving down to zero***: for most of the last 250 years, the philosophy guiding safety programs was that, while accidents were inevitable, action should be taken to prevent the most serious and the easiest to prevent. But through its own internal evolution over the years and influenced by the quality movement, the safety movement's most powerful safety systems have come to be premised on the idea of setting out to eliminate safety risk altogether – to design it out of the industrial system – so that safety is the norm in practice.

Why did safety goals change over time?

Over 250 years the basic shifts have been from an emphasis on:
- employee responsibility to management responsibility;
- post-accident coping[12] to prevention;
- non-systematic management to whole-system management;
- risk reduction to risk elimination.

Why?

For 250 years there was an ongoing struggle to avoid or force the acceptance of responsibility for accidents and *to make those with the greatest leverage over the root causes of accidents take the greatest responsibility*.

In these struggles all parties have tried to get governments to act for their interests. Governments are constantly reengaged by people and businesses because, for better or for worse, governments have the power to control or influence what smaller parties (people, organisations) do and because there are a host of issues that smaller parties cannot manage well in their atomised state and there are certain powers (eg. taxation and law making) that only governments have.

Over 250 years this struggle has led to the evolution, by trial and error, serendipity and analysis, of an increasingly sophisticated and effective way of handling safety because, in the end, the emerging system was actually in most people's and organisation's best interest.

Sometimes important developments in the evolution of the industrial safety system didn't occur in a logical order.

A major, unintended but highly beneficial development occurred in the 1880s as a result of the decision by Germany's Chancellor Bismarck to introduce a universal accident insurance scheme. This move, while following the long tradition of Prussian welfare statism, was as much as anything a deft political ploy to win back the support of the German working class from German socialists. Bismarck had intended that the German state would pay for the insurance through taxes.

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[12] eg. accident insurance.

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However, some of Bismarck's conservative political allies baulked at this proposed state expenditure and they made it a condition of their support that the insurance costs would be covered by German employers. So by chance, the cost of accidents was partially internalised for German companies. The hard evidence that this was the best place to locate the cost of workplace accidents came later.

For example, it was two decades later in 1910, that Crystal Eastman published a major report, *Work accidents and the Law*, presenting results of research by the Russell Sage Foundation examining industrial accidents in the US city of Pittsburg. A key finding of Eastman's was that, despite employers believing that about 95% of accidents were the fault of employees, in fact 74% of accidents were partially or wholly the fault of the employer[13]. Of the accidents that were directly and wholly the fault of the employee, one third were sustained by young, inexperienced or physically vulnerable workers. That meant that only 22% of those suffering accidents were able-bodied and careless. Eastman's comments about these employees was: "If 100 times a day a man is required to take necessary risks, it is not in reason to expect him to stop there and never take an unnecessary risk. Extreme caution is as unprofessional among men in dangerous trades as fear would be in a soldier.'[14].

In the years that followed, across the industrialised world, governments took progressively more steps to shift ultimate responsibility for safety to managements and to 'internalise' an increasing proportion of the cost accidents into the balance sheets of firms.

Once the cost are substantially internalised, it turns out that in a mass-production society, where the cost of designing out accident risk can be spread across a large number of products, it is almost always cheaper in the longer term to prevent accidents than for managements to wear the cost of accidents. Furthermore, as people's incomes rise, people generally prefer to absorb any residual costs of eliminating imposed[15] risks of accidents.

Once these dynamics apply, as has been discovered over and over by quality professionals, the most effective way to design out accident risk, at least cost, is to adopt a whole-systems perspective. And the best way to frame the design problem to maximise effective innovation is to aim for the elimination of risk rather than just aim for a partial risk reduction. After all, would "acceptable risk" continue to be acceptable if it was in fact possible to dive down to effectively zero risk at a cost (if any) that was acceptable?

One reason for an accelerated change in safety goals over the last half century or so is the increasing interplay between the safety system and the quality system of organisations. The two systems merged during the Second World War when quality management systems were used to boost the productivity of war production and the methods were used to ensure that what was produced, from

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[13] 30% were wholly the employers fault.
[14] MacLaury, US Dept. of Labor.
[15] Risk that people do not choose to take on.

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ships to bombers, tanks and munitions, posed the least possible safety risk. Since that time the two systems have continued to cross pollinate.

The discussion above about why industrial safety goals changed over the last 250 years, is written in a way that suggests that the evolution of the safety goals had a directional logic to it. But is this a valid way to present the material? The case of DuPont suggests that it is valid.

One of the earliest leaders in the industrial safety field was the DuPont company, founded in 1802 as a gunpowder manufacturer. The company's first safety rules were introduced in 1811 confirming that management was responsible for safety. The company history makes it clear that prevention was an essential strategy from day one, given the highly dangerous nature of what the company first produced.

So DuPont had no need to go through the first two transitions (employee responsibility to management responsibility, post-accident coping to prevention). Not surprisingly given its head start, DuPont was one of the earliest companies to complete the second two transitions (non-systematic management to whole-system management; risk reduction to risk elimination).

In the 1940s the company developed the safety philosophy that "all accidents are preventable". This belief underpinned a safety culture that produced substantially better results than the prevailing average for industry as a whole and, more significantly, for the chemical industry. DuPont eventually turned safety consulting into one of its areas of business. In the 1990s, DuPont began to use the slogan "the goal is "0"[16] ie. zero injuries and zero incidents.

Given that DuPont was well ahead of the external pressures that drove other companies to make changes in their safety management, and that it was largely driving itself through the stages of safety system evolution, this tends to suggest that there is indeed a logical progression in the four transitions.

The evolution of safety (and quality) slogans

	Safety	Quality[17]
1910	**"safety first"**	
1940s?	**"all accidents are preventable" (DuPont)**	"right first time"[18]
1990s	**"the goal is "0"[19] (DuPont); "zero harm"**	"zero defects"[20]

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[16] The "zero" stretch goal concept was originated by the quality movement in the US aerospace industry (from the 1960s) in the form of the "zero defects" goal and inspired by the application of the "zero defects" idea by the global car manufacturers (from the 1990s).

[17] Quality slogans are included because the safety and quality methods influenced each other and coevolved over the 250 years since the beginning of industrialisation.

[18] "Fit for purpose" and "right first time" are the two signature concepts of the Quality Assurance wing of the quality movement. The quality assurance approach superseded the quality control approach that was based on eliminating poor quality products through inspection.

These days, most of the large multinational companies in the potentially very risky industries of chemicals, resource processing and mining industries have adopted strong workplace safety programs and it is now increasingly the norm for these programs to be based on a "zero harm" stretch goal. The same is true in the consumer services field for aviation operators and aeronautics manufacturers where "failure is not an option".

Safety methods for high complexity contexts

The Second World War gave rise to a trend to develop highly complex socio-technical systems. This has necessitated the development of safety methods that go beyond reliability-based strategies. The safety methods for highly complex systems focus on the application of safety constraints and then develop socio-technical processes to maintain the system within the safety constraints. This history and the new methods are described in detail in Leveson (2011).

Climate – the biggest safety issue of all time?

The climate issue is probably one of the biggest safety issues of all time, vying for the grim title with the impacts of large-scale nuclear war. It therefore needs to be approached using the best possible safety methods.

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[19] The "zero" stretch goal concept was originated by the quality movement in the US aerospace industry (from the 1960s) in the form of the "zero defects" goal and inspired by the application of the "zero defects" idea by the global car manufacturers (from the 1990s).

[20] The zero defects concept was developed by Philip Crosby sometime between 1957 and 1964 when he was working for the US aerospace company, Martin Marietta Corporation.

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