Safety Management; Technology & Health

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Introduction

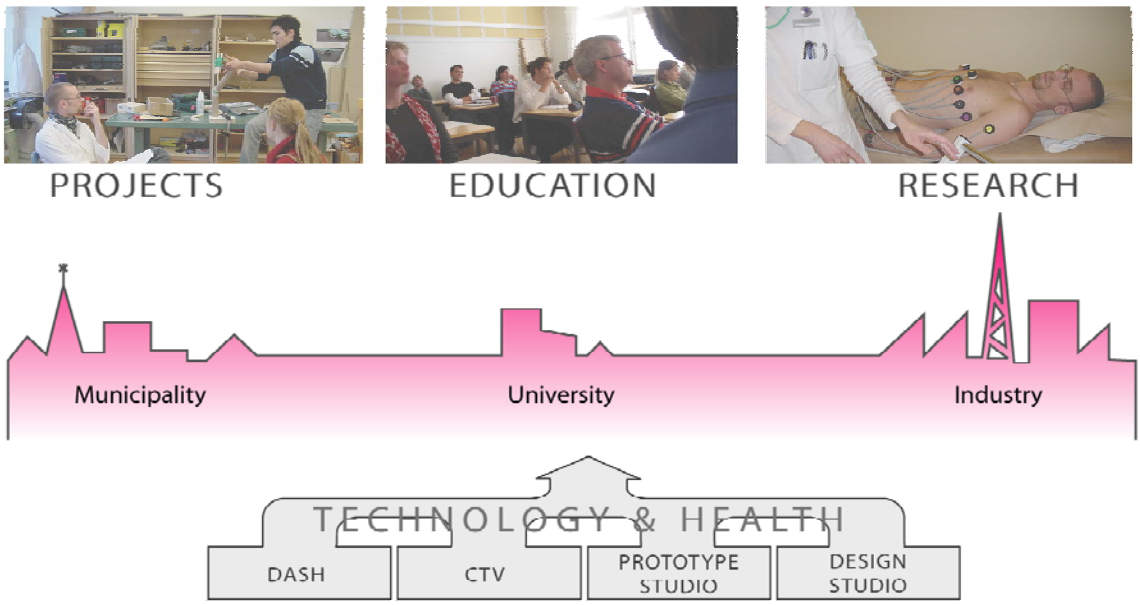
The main research subject at the Swedish Royal Institute of Technology **School of Technology and Health** describes and analyses

> "the multi-disciplinary relations between technology, design, built environment and clinically applied medicine - and the work processes - which influence safety, health and well-being".

This is an applied subject, where empirical research and problem-solving are the main criteria for good results. It is particularly true for the area of **industrial ergonomics and safety management**, which includes

> .."the design of equipment, processes and buildings, the functional use of work environments, the social processes defined by the character and organisation of work, and the effects of environmental and organisational design on safety and health."

The research area of **social and occupational risk** and the **management of safety** is the topic of this presentation.



The Management of Safety

The management of safety represents the broad and general task of preventing accidents and traumatic injury in the different arenas of activity in society where people are exposed to risks.

All societies need to develop and apply safety management methods to control risks in industry, on the roads and in the local community. The pace of economic, political and technological development is fast and when change is considerable and comes fast, the need to control safety tends to be the greatest.

To manage safety you must understand risk and the complexity generated by the fact that risks appears as **exposure** variables or **management** variables at different levels in the social structure.

RISK	
EXPOSURE	**MANAGEMENT**
System of production	Cultural patterns
Technical-economic structure	Political-legal system
Arenas of activity	Norm systems
Patterns of activity	Attitudes
Exposure situation	Personality
Acute risk situation	Individual coping skills

(Hovden & Larsson, 1987)

At the most abstract level, the *system of production* typical to society will define the types of risks its citizens are exposed to; the *technical-economic structure* will limit certain exposures and produce others; the *arenas of activity* offered by society – at work, in sports, in the home - will surely vary between countries and will generate specific risk exposures.

In the social group, the *patterns of activity* tend to vary and, among other things, define what risks are exposing those invoved in the respective activities. Each *exposure situation* is specific and so is each *acute risk situation*, where danger is imminent.

At each of these structural levels, from the most abstract and general to the specific and individual, different ways of managing the risk exposure is developed. The *cultural patterns* adopted will be coping with some risks and ignoring others; the *political-legal system* will generate inspectors or lawyers; the prevailing *norm systems* will define what is acceptable levels of risk.

Different social roles in relation to risk imply different *attitudes to risk*; *personality* traits can be important in explaining behavior in the face of risk; and we know that individuals differ in their skills in *coping with acute threats to life*.

The way risks appear on all and each of these levels can be important for the understanding of how we can control and manage risk in society.

2 Accidents and injuries at work

Our special focus here is the control of risks for occupational accidents and injuries at work. Occupational trauma risks have certain characteristics, which are important to understand and judge correctly when assessing the type of control measures needed.

Occupational accidents and injury risks are

- unevenly distributed over industries,
- unevenly distributed over severity,
- unevenly distributed over costs, and
- perceived as dependent upon behavior.

2.1 Uneven distribution over industries

Occupational risks are extremely skewed in all societies, and the stability with which certain types of work continue to injure and kill at much higher poportions than other types of work, is a source of frustration to the managers of safety and to those involved in prevention.

UNITED KINGDOM 1884-94

Occupation	Numbers employed	Work-related fatalities 1884-94	
Factory workers	5,270,835	4,047	1/10,000 pa
Railway employees	381,626	4,717	1/1,000 pa
Seafarers	188,391	21,241	1/100 pa

(Seamen's Compensation Review, 1988)

The fact that seafarers were 100 times more likely to die at work compared to factory workers in the United Kingdom in the period 1884-94 reflected the technology of sea transport in the late 19th century. However, the risks faced today by fishermen in small coastal fishing vessels in many waters around the globe, where the big trawlers have vacuumed the seas for fish and supply is low, are comparable. Thus,

technology has changed the risk and economics and politics have changed it again. The great discrepancies between a few occupational groups at very high risks and many occupational groups with low or medium risk levels at work seem to persist.

2.2 Uneven distribution over severity and cost

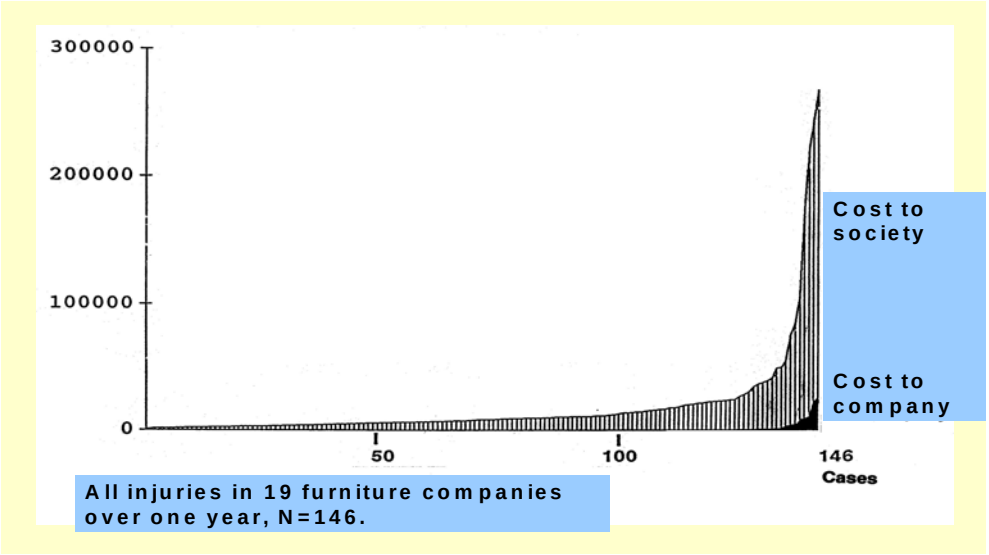
The job role of most industrial occupations implies a technologically determined homogeneity of exposure, where current equipment, machinery, material and tasks tend to be similar for most of those active in the occupation. The occupational title represents the closest description of hazardous exposure available.

In the Swedish national claims database for the years 1997 through 2001, the same nine occupational groups exhibited consistently high occupational risk levels. Each year, these occupations are exposed to a 400% higher risk of meeting with a permanent medical impairment or fatality due to injury at work compared to the national average. The figures are surprisingly stable.

Occupational groups	**Risk (number of permanent impairment cases/ fatalities per 1000 employed) 1997-2001**
Concrete worker	**9.0**
Sawmill worker	**7.3**
Wood products industry worker	**6.8**
Seafarer, deckhand	**5.1**
Miner, driller, quarry worker	**4.9**
Glazier	**4.8**
Panel beater	**4.6**
Dairy, bakery, brewery, food worker	**4.1**
Welder	**4.0**
.....	
Total 1997-2001	**1.0**

We have suggested to the ILO and the European Union that an occupational risk level, calculated in this way, might constitute a 'limit value' against which defined industrial activities can be assessed in terms of safety regulations, compliance control priorities and prevention (Larsson & Forsblom, 2004).

Medical severity is unevenly distributed and so are the economic consequences of injuries at work. If all lost-time injuries in a company are recorded, the majority of accidents only lead to minor consequences.



(Söderqvist et al. 1987)

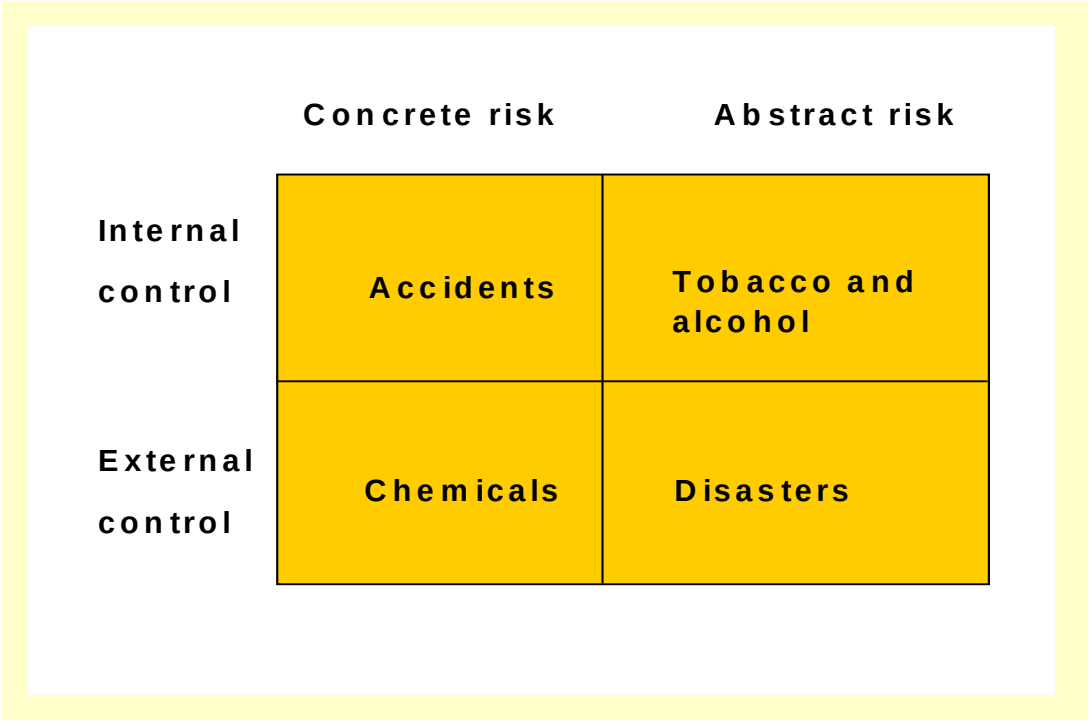
This is illustrated by the cost of all 146 known injuries in 19 Swedish furniture companies over one year. The proportion of the total injury cost, which is picked up by the company in this system is very small. Naturally, this will vary between different countries and be dependent upon how tax, insurance, social welfare and regulatory systems are structured.

2.3 Dependent upon behaviour

Maybe the most unique characteristic of occupational accidents is that they are perceived – by most of us – as dependent upon the behaviour of the victim. Unlike other hazards around us, the risk of meeting with an accident, i.e. to suddenly become involved in an unplanned and unforeseen process of events leading to injury, we tend to regard as determined by what we did, how we did it and that we failed in our intended behaviour and lost control.

The risk of traumatic injury at work is closely associated with the physical interaction between man and machine, between the human body and tools, equipment and loads. Instinctively, we like to regard the individual as being in command of the physical process of the work tasks he/she performs, and we tend to see the accidental loss of control of the work process as an indication of failure on the part of the worker, the victim.

It is also quite clear that accidental injury is a very different safety problem compared to more abstract risks, over which the individual is seen to exercise far less control.



(Hovden & Larsson, 1984)

Accidental processes leading to injury represent concrete and apparent risks and are also seen as controlled by the behaviour, the skills and the competencies of the exposed individual. This is in contrast to other prominent risks in the work environment, e.g. chemicals or other hazardous substances, which might be both concrete and prominent risk exposures, but which are seen as external to the behaviour of the exposed. Most workers on a construction site will view exposure to hazardous substances at work as a more prominent risk than meeting with an accident.

More abstract risks or risks where the consequences might be uncertain or hard to envisage are the hardest to manage. And any control measures or prevention activities adopted in the management of safety must be adapted to the characteristics of the risk in order to be effective.

3 To Manage You Must Measure

Occupational health and safety, and the incidence and severity of occupational trauma, is closely associated with the pace and character of industrial development. Technological change in manufacturing, agriculture and transport - modernization and rationalization of production methods, increased trade and production for export markets, increased investment in a skilled workforce and improved methods for systematic quality control - have all generally served to improve the working environment and reduce the exposure to injury risk.

And though it can be argued that technological development drives most of the improvement in the conditions of industrial work, at critical times in this process of

modernization policy-makers have relied on measurements of risk provided by different types of safety professionals:

- industrial safety inspectors have played a crucial role in the management of occupational safety from the 1880's and onwards,
- occupational hygiene and company health care specialists, together with medical specialists in the primary care and regional hospital systems have provided important information in relation to occupational injury and disease,
- the introduction of social and workers' compensation insurance have provided additional experts in the field of measurement of accidents and injuries related to work.

The growth of the field of industrial safety, particularly among petro-chemical, process and energy companies, where occupational safety has been a secondary outcome of investment motivated by the need to safeguard installations and natural resources, has seen the methods of systematic industrial safety management spread across the globe through the multi-national corporate networks.

3.1 The Safety Managers

In spite of the positive developments in occupational health in the industrialised world, safety remains poorly defined in most systems, modern and developing alike, and the practical responsibility for safety - the responsibility to avoid and prevent accidental injury and to control risk - is often in real terms a responsibility delegated to the risk-exposed worker.

A first step in the process of building systematic safety management is to clarify in practical terms who are the safety managers: To undertake successful safety management we need safety managers.

There are organisations, structures and institutions – public and private – in most systems where the potential safety managers are employed. We suggest that the safety managers are those professionals and experts working in government departments, at hospitals or medical clinics, in social and workers' compensation insurances, and in industrial companies, who have *close access to systematic information about the negative outcomes of work-related risks* in terms of injury incidence, medical severity and other social and economic consequences.

4 Strategic Questions and Information Systems

The basic questions for safety management are

Who are at risk? *Which are the typical risk occupations?*

Where are the risks? *What are the typical risk situations?*

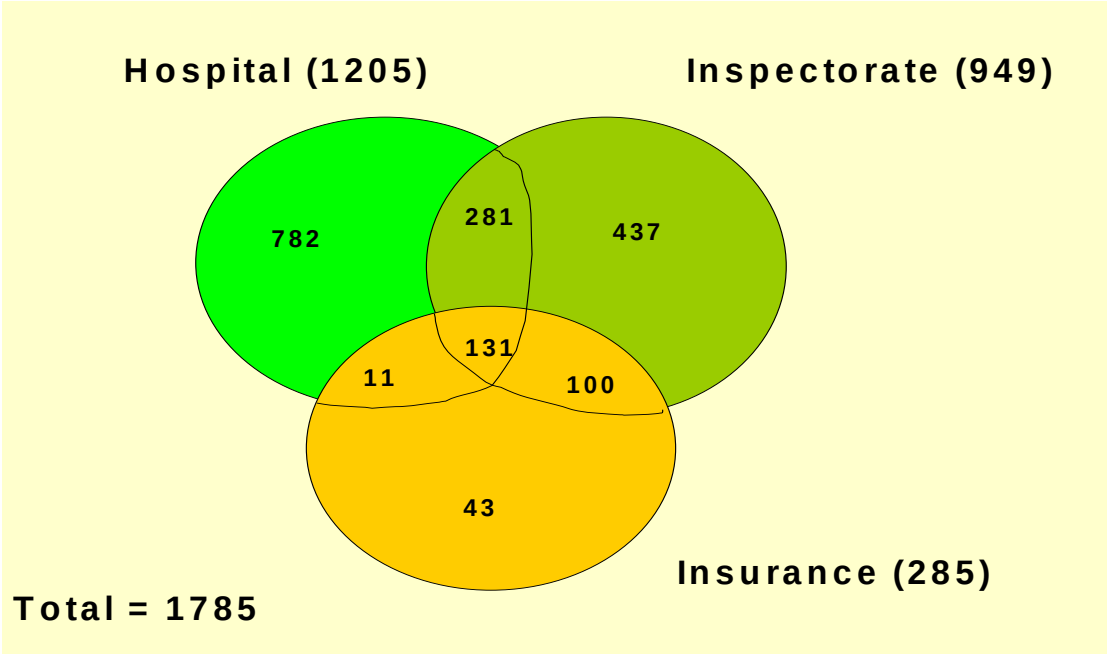
How are the injuries sustained? *Which are the typical accident processes?*

To answer these questions, systematic injury information systems must be built, maintained, quality controlled and strategically utilised. A well structured injury information system should be constructed so that it can

- measure risk based on exposure,
- measure injury severity,
- represent epidemiological variables credibly,
- provide longitudinal trend data,
- be used to measure potential effects of interventions.

There are – in principal – three different sources of systematic information about accidents and injuries at work; the type of information sources you need to measure risk systematically.

These information systems are either with the industrial safety inspectorate, at the hospital emergency department, or with the public fund workers' compensation insurance. These three information systems are built for different purposes, they contain different variables and will generate slightly different information about injury risks.

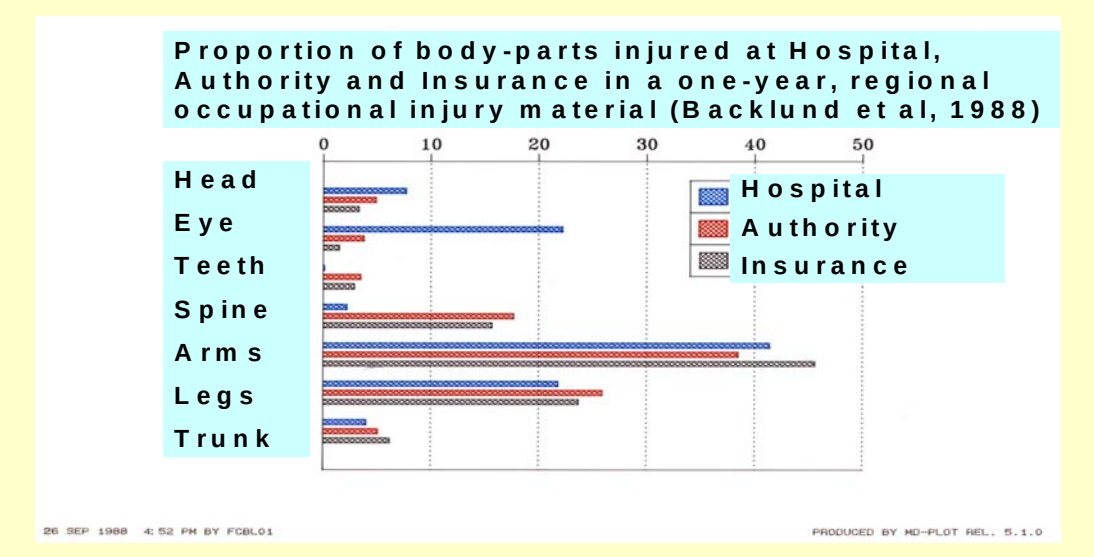


(Björnstig & Larsson, 1990)

An example of how the three information sources are related to each other, and what differences there are between them, is this one-year material from the Umeå region in the north of Sweden. In one year a total of 1785 work injuries were identified in the region – with the help of three different data sources: the emergency department, the industrial safety inspectorate and the workers' compensation insurance.

It is obvious from this study that the different criteria applied in these systems (i.e. acute medical need, notification to the regulator, claim for compensation) generate

very different information. Only 7% of the total number of injuries were known to all three systems, and the authors concluded that you would need the information in all three systems in order to correctly assess the full breadth of work-related risks in the region.



One further typical difference between the medical system, based on perceived acute medical severity, and the insurance system, based on claims for earnings-related compensation, is exemplified in this picture. If you hurt your eye you seek medical attention, but if you injure your back you go home (Björnstig & Larsson, 1990).

Let's take a closer look at the three different types of systematic data sources for safety management:

4.1 The Inspectorate Information

The inspectorate is focused on injury risks to exposed workers, on hazardous activities and on occupations with high injury risks - the practical work of the Inspector is the control of compliance with regulations and hazardous work practices in industrial workplaces. This will define the strategy.

The main restrictions on the effectiveness of the Industrial Safety Inspectorate is the lack of manpower and resources to inspect sites and assess risks before injury is sustained. In many systems, it is difficult to make the translation of information on exposures and hazardous activities into the systematic and efficient detection of non-compliant employers and industrial establishment.

Nevertheless, there is useful information in the Inspectorate systems, as exemplified by this comparison between Inspectorate and Insurance information on risk and inexperience from Sweden:

RISK & INEXPERIENCE

Experience	(Insurance) Impairment		(Inspectorate) Severe Injury	
	No	Risk	No	Risk
< 1 day	9	43	13	53
1 day - 1 week	16	25	18	24
1 week - 3 months	26	4	41	6
3 months - 1 year	29	1	34	1
> 1 year	138	-	213	-
Unknown	21	-	32	-
	239		351	

This is the type of information available to the Inspectorate in many systems: Severe and impairing injuries to wood industry workers by the experience of the

victim at the time of injury (Larsson, 1988). Assuming that the influx of newcomers to the industry is roughly even over the year, there is concordance between the information from the Insurance system (on permanent impairment injuries associated with wood-processing machine) and from the Inspectorate (reported accidents with severe consequences).

The risk of sustaining a severe or permanently impairing injury the first day on the job is between 43 and 53 times higher than the same risk after three months on the job. Thus, the procedures for initial introductory training on the job in this industry was shown to be a top priority for injury prevention.

4.2 The Insurance Information

The information in the claims-settling systems of workers' compensation or social insurance have the most extensive coverage of data necessary for the targeting of prevention and the management of safety. These systems cover injury type, diagnosis, medical severity, interventions and treatments, payments and costs.

More importantly, these systems also include extensive information on the pre-crash phase of the injury – the accident – and such systematic information is absolutely necessary for prevention.

The restrictions on insurance-based systems of injury information will be if the scheme is operated on the basis of private insurance, in which case normally only limited information on hazardous exposures and the distribution and priorities of risk will be available for prevention and the management of safety.

The system developed at the Accident Compensation Corporation (ACC) in New Zealand and applied in several Scandinavian jurisdictions has been integrated in the new EU reporting and recording standard. To describe the accident, three questions are included on the report form:

PRE-CRASH INFORMATION (ACCIDENT)

*** What was the person doing?**

eg. ... riding ... ... bike

*** What went wrong?**

eg. ... slipped ... ..oil-spill

*** How was the injury inflicted?**

eg. ... hit against ... lamp post

The responses to these questions can be recorded in free-text format or in a condensed verb/noun code.

The EU recording format contains information on the enterprise, the working conditions, the injured employee, the workplace, the sequence of events (the accident) and the injury:

ENTREPRISE
economic activity, size, location

WORKING CONDITIONS
working environment

EMPLOYEE
occupation
age - gender
nationality
occupational status

WORKPLACE
work process

SEQUENCE OF EVENTS
-specific physical activity, associated material agent
-accident mechanism, associated material agent
-contact/injury mode, associated material agent

VICTIM
type of injury, body part injured, days lost

The most important information in the insurance system are the details describing the consequences of injury; the consequences of traumatic injury that only the insurance will have systematic information about.

Some of the severity criteria available to the insurance, which can be used to set priorities for prevention are:

- duration of earnings-related compensation (rehabilitation period),
- days admitted as in-patient to hospital (threshold of medical severity),
- degree of permanent impairment (percentage according to medical criteria),
- forced early retirement (disability pension, annuity).

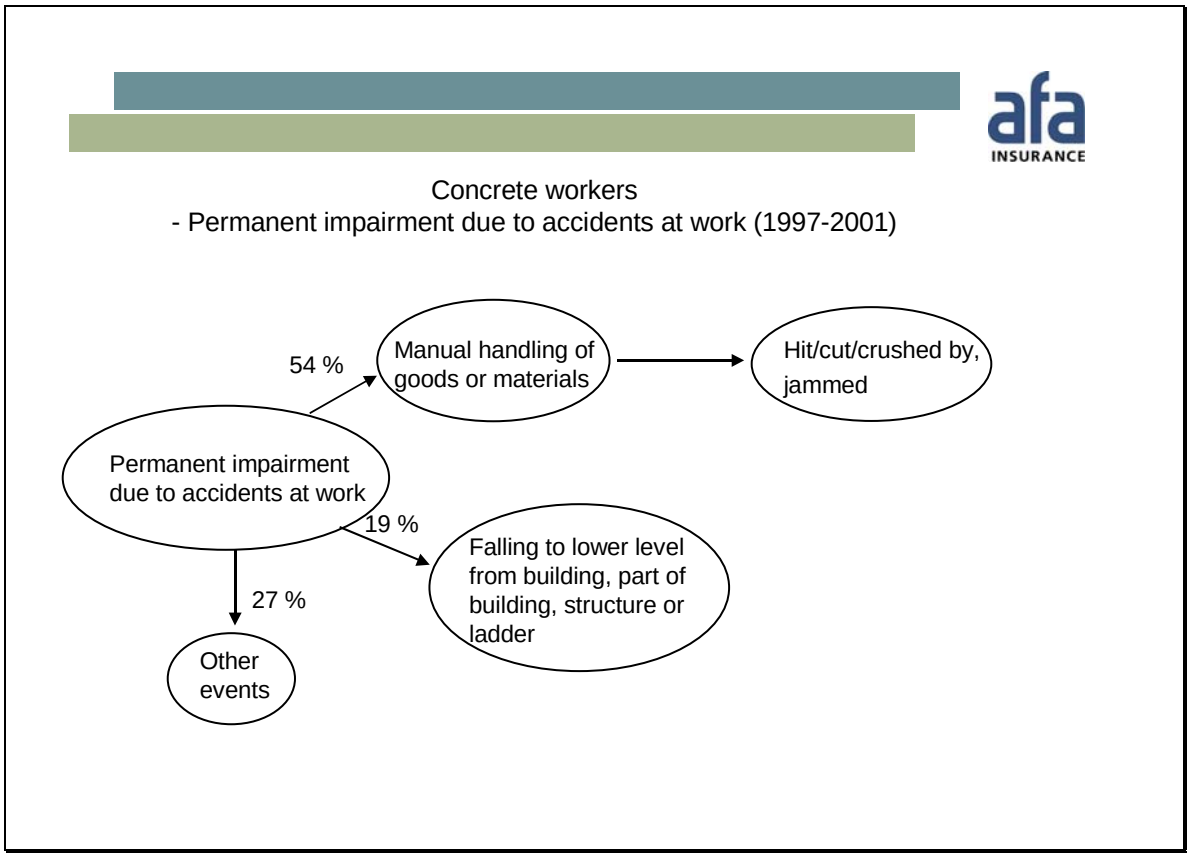
4.4 Insurance Information used for Prevention

Here are a couple of examples of how you can use insurance information to identify the priorities of prevention and link the consequences – economic and medical – to exposure and “pre-crash” information – to the activities and tasks that are associated with injury. The is from the National Labour Market Insurances of Sweden:

Ex 1

Permanent impairment due to accidents at work
- Annual risk (number of cases per 1.000 employed)

	Year of accident				
	1997	1998	1999	2000	2001
Wood industry workers	6.9	5.3	6.3	5.6	6.6
Mining, quarrying, stone-cutting	6.5	3.8	4.5	2.9	4.1
Metal work	2.8	2.6	2.6	2.7	3.3
Concrete, building, construction work	**3.3**	**2.9**	**2.7**	**2.3**	**2.8**
Food processing work	2.6	2.5	2.5	2.1	2.6
……..					
Pre-school teachers	0.5	0.3	0.4	0.3	0.3
Doctors	0.3	0.0	0.2	0.1	0.2
Nurses, mid-wives	0.3	0.2	0.3	0.2	0.2
……					
Total	1.0	0.8	0.8	0.8	0.8



(AFA, 2004)

Presently, the large data-bases on occupational injury in the Swedish workers' compensation system are being developed into interactive decision support tools for local safety management. Specific index measures have been created for different industries (Construction, Pulp & Paper, Metalworking, County-councils/hospitals, etc), where safety performance can be measured on a very detailed level.

To illustrate the power of a decision support tool, clusters of similar accidents are identified in the information system, and this is what you can get:

HIT BY / AGAINST TOOL **Ex 2**

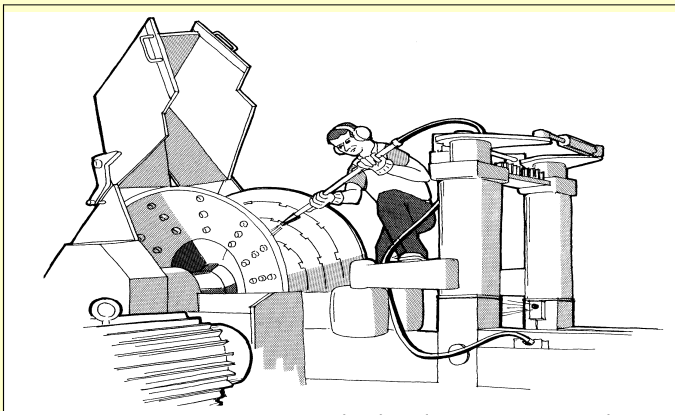
Fracture of arm or leg

Average: 113 days (10 cases)

Average: $25,600 (excl. maim benefits)

Elimination: Guard or switch preventing access to machine before standstill. New disk brakes on the shafts of rotating parts.

Cost: $50,000 for a medium-sized mill



(Söderqvist & Larsson, 1990)

Large rotating machines, like this de-barker, need to be cleaned quite often. This is done with pressurized air. Often operators don't take the time to let the rotating machine stop – this can take several minutes – but they start cleaning the machine while it is still rotating.

In the year of analysis, we found 10 identical injury cases of arm or leg fractures associated with this task. The average lost time was 113 days at an average cost of US$51,200, and the elimination measures were identified as either a guard/switch to prevent access to the machine before standstill, or the retro-fit of disk brakes on the shafts of rotating machine parts. The cost for this was estimated at US$100,000 for a medium-sized mill.

This is what safety management is:

- locate, collect, combine and analyse information,
- identify priorities,
- intervene and prevent,
- measure effects.

5 Safety Management in the Company

The perspectives of Industrial Safety Management can be of several different types:

Industrial Safety Management Perspectives

ENERGY - use, storage
HAZARDS - failure modes, technical functions
WORK - job tasks & work processes
SYSTEM - interactions & deviations

PROCESS MANAGEMENT
- risk, change, supply chain, system.

The perspective chosen would depend on the complexity of the production system and the hazards involved. Simple manufacturing without technologically sophisticated processes, with limited amounts of energy stored and used, and with a large number of manual work tasks should be advised to concentrate on safety management systems based on assessments of job tasks, work processes, interactions and deviations.

On a more advanced level, there are some key components to a good and functional Safety Management System in a corporation:

Management of Safety in the Company:

- **systematic risk assessment**
- **control of high risk activity**
- **preventive maintenance**
- **the management of change**

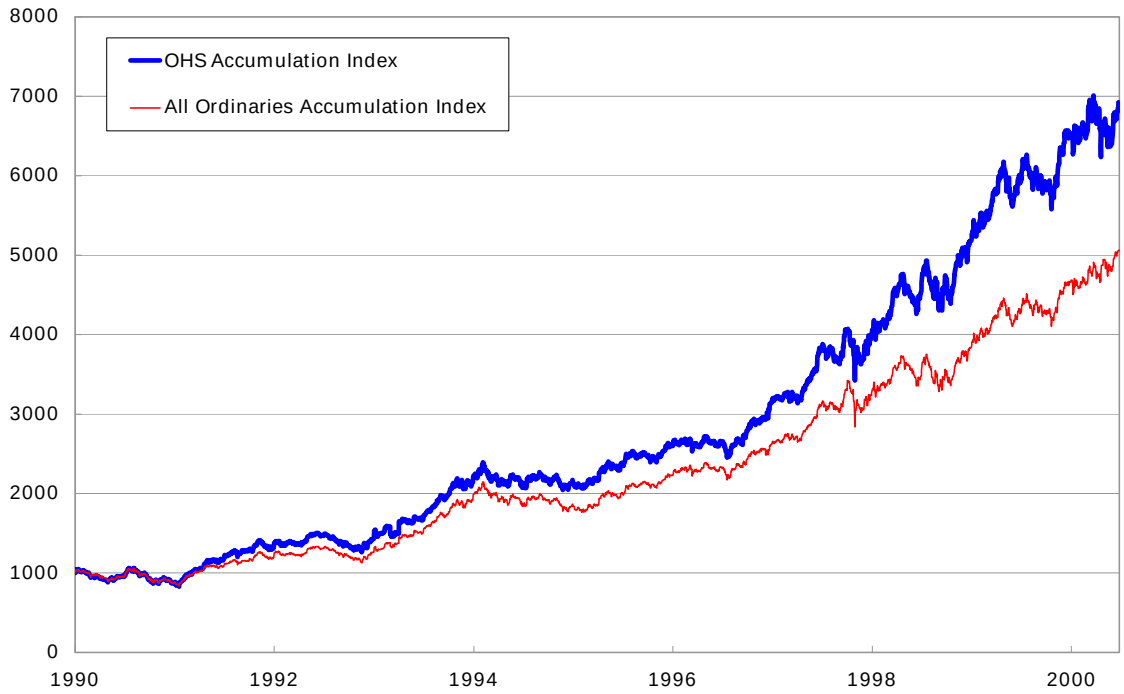
And, in addition to this, the practical application of the safety management system can depend on if it is *proactive* or *reactive*. The assumption of the good safety management system is that risks are identified in a systematic manner – before injury - so that proactive interventions against the identified risks can be made and injury be avoided. If the safety management system is applied bureaucratically or simply to comply with regulations, a reactive approach will assess risk based on injuries alone and thus only intervene once the damage already is done. A reactive safety management system is an example of sub-optimization of resources.

There are proven links between productivity, profitability and good safety management. A few years ago we were asked by a large Australian merchant bank to develop a survey tool for OHS & safety management performance and to survey the 150 largest companies on the Australian stock exchange.

A survey form with 118 items in 16 different areas of corporate safety management was constructed (Standards Australia, 1997; NSCA, 1998). A condensed version of the survey, with less than half the number of questions, was deemed sufficient for industries with no or low apparent physical risk exposure, eg. banks and financial institutions.

We rated the companies on their Safety Management Systems and Performance and this rating was used by the portfolio manager at the bank to put together a “best of sector” share investment fund based on 51 companies. To test the performance of the portfolio it was “back-tracked”, i.e. tested in theory retrospectively over the last 12 years, with the caveat that such testing only include the companies who have survived, which must be taken into account when judging the outcome:

This test indicated that the companies in the OSH Good Performance Portfolio performed 40% better than the stock-market average over 12 years. The conclusion is that good safety managers are good managers and the companies which are managed well perform overall better than average (Larsson, Dell & Maher, 2004).



6 Conclusions

Practical safety management systems are built by competent and laterally thinking professionals in all the institutions above – in cooperation.

The industrial society needs to maintain good systems for inspection and control -- to uphold the law and improve working standards. But it also needs to work hard in targeted and applied occupational injury prevention and keep up with the pace of industrial development and globalization.

Please remember that occupational health and safety exists in an area of partial market failure. There is a great need for improved occupational health and safety in some areas of work, but a patchy demand for this in the market. Occupational health and safety is first and foremost a question of public health, and as such it will remain an important public responsibility.

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International Expert Network on Occupational Accident & Trauma Prevention at*www.workingonsafety.net*