

**CONCORDIA UNIVERSITY  
FACULTY OF ENGINEERING AND COMPUTER SCIENCE**

**ENGR 201  
PROFESSIONAL PRACTICE AND RESPONSIBILITY**

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## **CHAPTER 3**

### **SAFE WORK PRACTICES**

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#### **TOPIC 1 : GENERAL SAFETY CONCEPTS**

##### **OCCUPATIONAL HAZARDS : RISK FACTORS**

- A definition of risk factors
  - "Each of the elements of a system which contributes to an increase in the probability of an event, change or failure in that system, thereby making it less reliable"
- Risk factors
  - Usually, there are a lot more than the obvious few
  - Finding them requires a systematic analysis
  - Not all equal in danger level, probability and preventability

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## RISK FACTORS

<b>INDIVIDUAL ABILITY</b>  » physical » mental » altered capacities (age, fitness, disease / medication; stress, obsessions, motivation)	<b>TRAINING AND EDUCATION</b>  » re : task » re : operation » safety training » information about risks » information about hazardous materials	<b>BEHAVIOUR</b>  » gross or wilful neglect » insubordination » intoxication	<b>WORK ORGANIZATION</b>  » selection and preparation of work methods » staffing level and quality » task preparation and planning » work station design » control of physical nuisances
<b>TASK DEFINITION AND EXECUTION</b>  » preparedness of original task » repetitive task analysis » deviation from definition » deviation during execution » operator-selected task » mental work load : monotony, complexity, schedule, cadence	<b>COMMUNICATION</b>  » codes, language, signs » foreign language » distorted perceptions » coordination » control, surveillance » unsupervised isolated work	<b>OCCUPATIONAL HEALTH AND SAFETY STANDARD AND REGULATION</b>  » violation of law, regulation, standard » voluntary excesses (speed, load, pressure,...) » mishandling hazardous materials » unavailability / inadequacy / misuse / no use of individual protective equipment	<b>SUPERVISION AND CONTROL</b>  » absence of control (procedures, safety measures, regulations, standards, instructions) » lack or insufficiency of supervision (duration, frequency, intensity, competence)
<b>EQUIPMENT</b>  » bad or inappropriate design » bad quality / original defect » lack of integrated protective devices (dangerous machines) » wear and tear / lack of maintenance / disrepair	<b>HAZARDOUS MATERIAL</b>  » wrong material » chemical incompatibilities » bad / insufficient information (WHMIS*, including MSDS*, labelling)	<b>INTERACTION WITH NEARBY MATTER / ACTIVITY</b>  » falls from above » projections of materials / pieces from nearby operations » fixed or mobile obstacles » pressurized liquids / gases leaks / projections » toxic / corrosive liquids projections » hot or burning solids / liquids / gases » heat radiation » intense light or flashes » explosions / blasts	<b>PHYSICAL ENVIRONMENT</b>  » lighting » visibility » shapes and colours » circulation surfaces (uneven, slippery, obstructed, openings...) » narrowness, confinement, difficulty of access » noise and vibration » temperature, ventilation, fresh air, heating, A/C » posture

\* WHMIS : Workplace Hazardous Materials Information System

\* MSDS : Material Safety Data Sheet

**A SIMPLE TOOL : THE RISK INDEX**

- The Risk index (R.I.) is a simple, quick indicator that can be used to establish priorities with respect to occupational health and safety.
- Many methods of risk evaluation exist. This is the topic of another chapter.
- Calculating the Risk Index :

$$\mathbf{R.I. = C \times E \times P}$$

where :

**C** = consequence (most likely result)

**E** = exposure (presence of the danger)

**P** = probability (events lead to accident)

<b>WHEN THE...</b>	<b>IS ESTIMATED AS...</b>	<b>ITS ASSIGNED VALUE IS...</b>
<b>CONSEQUENCE</b>	catastrophe or multiple deaths	100
	death	75
	total permanent incapacity	50
	partial permanent incapacity	25
	total temporary incapacity	10
	medical intervention	1
<b>EXPOSURE</b>	all the time /several times a day	10
	often /daily	6
	usually / weekly to monthly	3
	occasionally / monthly to yearly	2
	rarely	1
<b>PROBABILITY (not mathematical)</b>	very likely	10
	50/50 chance	6
	unusual	3
	exceptional	1
	unbelievable	0,5
	nearly impossible	0,1

- Result : 0,1 to 10 000
  - Above 3000 : act now, it is very urgent
  - Between 1000 and 3000 : intervene quickly

- Below 1000 : treat each case individually
- An example : A compressed gas bottle falls
  - The bottle hits somebody's foot, then something solid and its valve is broken off
  - Two possible outcomes are identified :
    - the person suffers a broken foot
    - the bottle shoots away like a rocket
  - Risk index =  $C \times E \times P$ 
    - Foot hurt : R.I. =  $10 \times 10 \times 4 = 400$
    - Rocket away : R.I. =  $75 \times 10 \times 4 = 3000$
    - Total (sum of all risks) = 3400
      - ↳ immediate action required : tie the bottle, put its cap on
  - Other possibilities :
    - The gas is dangerous (toxic, flammable, etc.)
    - The bottle falls to a lower level
    - etc.

### **AT THE UNIVERSITY : WHAT IS THE SAME, WHAT IS DIFFERENT**

- What is the same
  - Standard risks associated with buildings, chemicals, machines, etc.
  - The same laws and regulations apply
- What is different
  - No "production" involved
  - Experimental situations : the risks may be unsuspected,
  - Untrained and changing "workers" : the student
  - Multiple processes occur at the same time : teaching, working, learning...

## **TOPIC 2 : ACCIDENTS**

### **DEFINITIONS**

- "industrial accident" means a sudden and unforeseen event, attributable to any cause, which happens to a person, arising out of or in the course of his work and resulting in an employment injury to him;

- "occupational disease" means a disease contracted out of or in the course of work and characteristic of that work or directly related to the risks peculiar to that work

(from *An Act respecting industrial accidents and occupational diseases*, R.S.Q., chapter A-3.001<sup>1</sup>)

### WHY ACCIDENTS HAPPEN

- "HOW", "WHEN", "WHERE" and "WHAT" are usually easy to find
- Many possible answers to "WHY", depending on perspective
- Accident causes (CCOHS)
  - What caused it ?

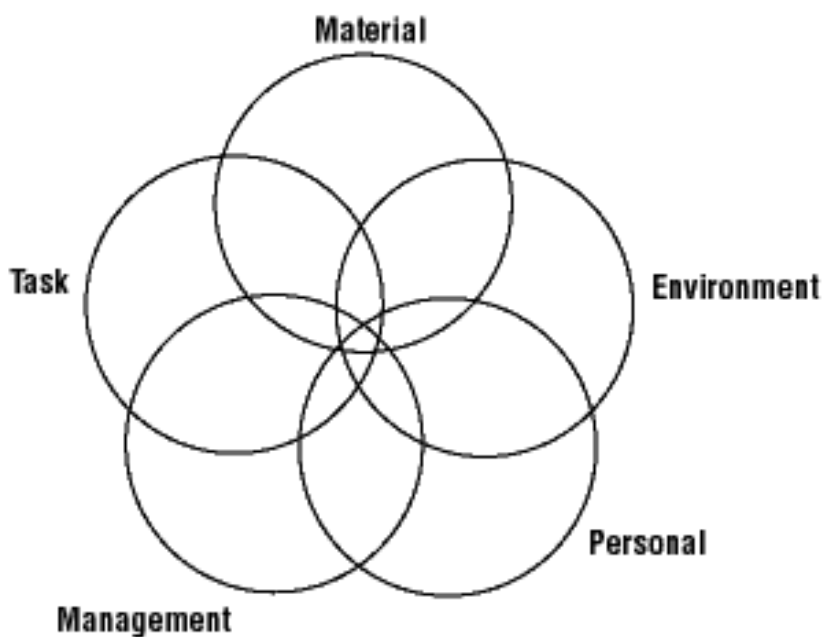
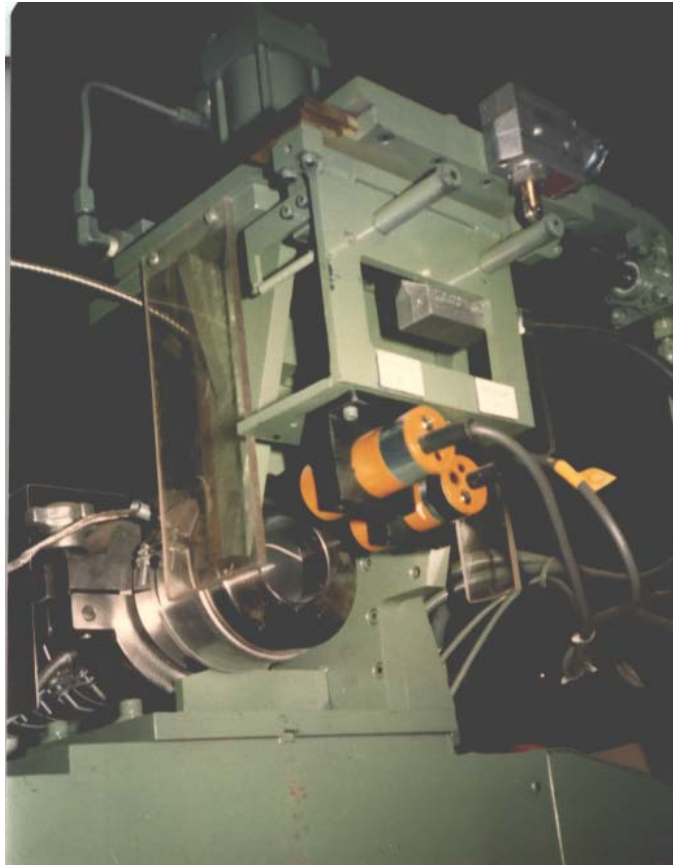


Figure : Accident causation (Source : CCOHS<sup>2</sup>)

<sup>1</sup> <http://www.publicationsduquebec.gouv.qc.ca/home.php#>

- Example : amputation of a thumb in a plastic extruder



- Location : small appliances factory
- Triggered by proximity sensors (the two yellow cylindrical devices), the shear that should cut off extruded plastic "slugs" cuts off the operator's thumb off instead as he tries to start the process by preventing plastic pellets from being simply pushed out of the heating chamber (the stainless steel piece to the left of the sensors) unmolten
- Brand new machine (less than a day of use) : unfamiliar
- Untrained worker
- Machine ordered/sold/installed without the "safety barriers, painted yellow" mentioned in its specifications
- Incomplete/missing instructions manual
- Language

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<sup>2</sup> Canadian Centre for Occupational Health and Safety

- Example : fork lift operator crushed to death



- Location : the distribution centre of a transportation company
- Operation : loading pallets into truck
- Truck leaves without warning as fork lift enters trailer with a load
- Sudden fall between dock and trailer : the propane tank located behind the operator's seat is pushed forward, crushing the operator between the seat and the steering wheel.
- The driver dies of internal injuries.
- No coordination : the truck driver did not know that the loading was not completed
- No safety system : neither the fork lift operator nor the truck driver knew what the other was doing.

- Accident analysis
  - To prevent reoccurrence of ...
    - Aircraft crashes
    - Nuclear or chemical disasters
    - Common mode failures
    - Fires
    - Falls
    - ... and "ordinary" accidents
  - Other types of analysis of the same events for different purposes often lead to different conclusions
    - Exemple : Two firemen killed and several wounded by the collapse of the Unitarian Church on Sherbrooke St. West during a major fire on May 25, 1987
      - Old (early 1900s), unusual design
      - Criminal activity
      - Material (cast iron columns) failure under intense heat
      - Firemen in wrong place at wrong time

### **TOPIC 3: PREVENTION**

#### **GENERAL CONCEPTS**

- The ultimate goal : the elimination, at the source, of dangers to the health, safety and physical well-being of workers.  
(*An Act respecting occupational health and safety* R.S.Q., chapter S-2.1)
- Three main means of intervention
  - Planning and organization
    - Health and safety program responsibilities at the operational level
    - Health and safety procedures
  - Practical means
    - Safety standards
    - Collective protection equipment
    - Individual protection equipment

- Training and information
  - Posted safety warnings
  - Procedures
  - Operating manuals
  - Supervision
  - WHMIS (Workplace Hazardous Materials Information System)

### **AT CONCORDIA UNIVERSITY**

- Environmental Health and Safety Office  
<http://ehs.concordia.ca/index.php>
- Policies, programmes, procedures
  - Excerpt:

Effective institutional management of environmental health and safety requires an interdisciplinary approach with full participation of employees and managers at all levels of the organization to ensure that adequate attention is given to the health, safety and physical well-being of all personnel, students and visitors to our premises and to the protection of the environment. To this end, Concordia has established a health and safety system. It is intended to be a proactive internal responsibility system permitting the full participation of all stakeholders, rather than a reactive approach driven by minimum regulatory requirements. The challenge is to reach a comfortable balance between the ideal and the possible.

The University is not exempt from occupational health and safety and environmental legislation. There is a myriad of laws and regulations affecting nearly every aspect of our organization, particularly research, service, academic or recreational functions involving hazardous materials or risky activities capable of causing injury, illness or environmental damage. Beyond the legislative requirements, there is a general obligation to be duly diligent in this regard. As an institute of higher education we may even have a moral and ethical responsibility to provide leadership in these areas as an integral part of our educational mission and social responsibility.

- Manuals
- Training
- Emergency response
- Resources

### **CONCLUSION**

- Health and safety are a paramount concern for engineers
- Ideally, dangers would be eliminated at their source
- Realistically, decisive risk factors must be identified and controlled
- Many accidents could be avoided with fairly simple and cost-effective prevention measures.
- When "things happen", consequences must be minimized and measures taken to prevent a reoccurrence.
- Accidents or incidents are a very valuable source of information and should be thoroughly investigated.

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### **REQUIRED READING**

- Concordia University - Laboratory Safety/ Hazardous materials
  - <http://ehs.concordia.ca/hm/index.html>
  - Look at the various manuals, procedures and forms and familiarize yourself with their general scope and purpose (you are not required to read them all from beginning to end)

- **SUGGESTED READING**

- Concordia University - Office Ergonomics Manual and Self-Assessment Checklist
    - <http://ehs.concordia.ca/ih/ergo.html> : look for the "Office Ergonomics Manual" and the checklist under Ergonomics
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**A FEW REFERENCES**

- Canadian Centre for Occupational Health and Safety (CCOHS):
  - <http://www.ccohs.ca/>
- Commission de la santé et de la sécurité du travail du Québec (CSST):
  - <http://www.csst.qc.ca/index.htm>
- Human Resources Development Canada - Occupational Health and Safety - Labour Operations :
  - [http://www.rhdcc-hrsc.gc.ca/eng/labour/health\\_safety/index.shtml](http://www.rhdcc-hrsc.gc.ca/eng/labour/health_safety/index.shtml)