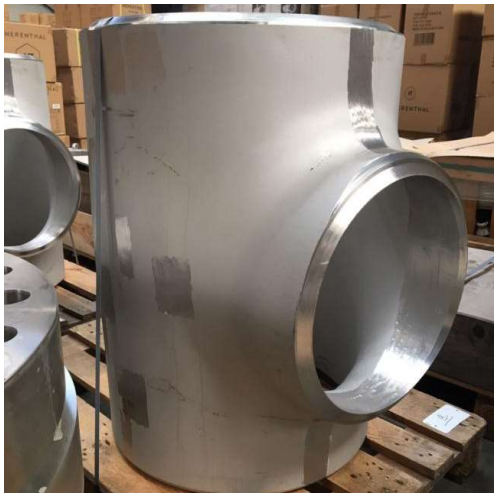
The Role of Corrosion Management in Process Safety



Alec Groysman

alecgroysman@gmail.com

www.alecgroysman.com

Technion (The Israel Institute of Technology), Haifa, Israel

Israel Society of Chemical Engineers & Chemists, Tel Aviv

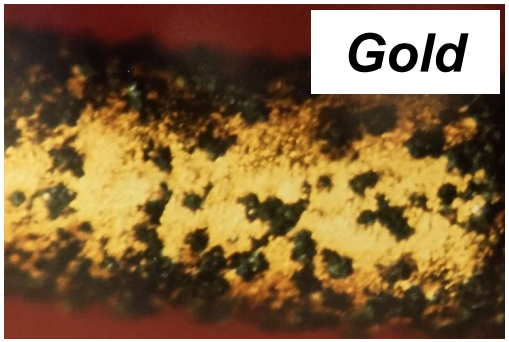
13th Biannual Conference of the Israeli Corrosion Forum

8 November 2018 Tel Aviv, Israel

There are no absolutely resistant materials!

Corrosion Resistant Material?

Corrosion Resistant Alloy?

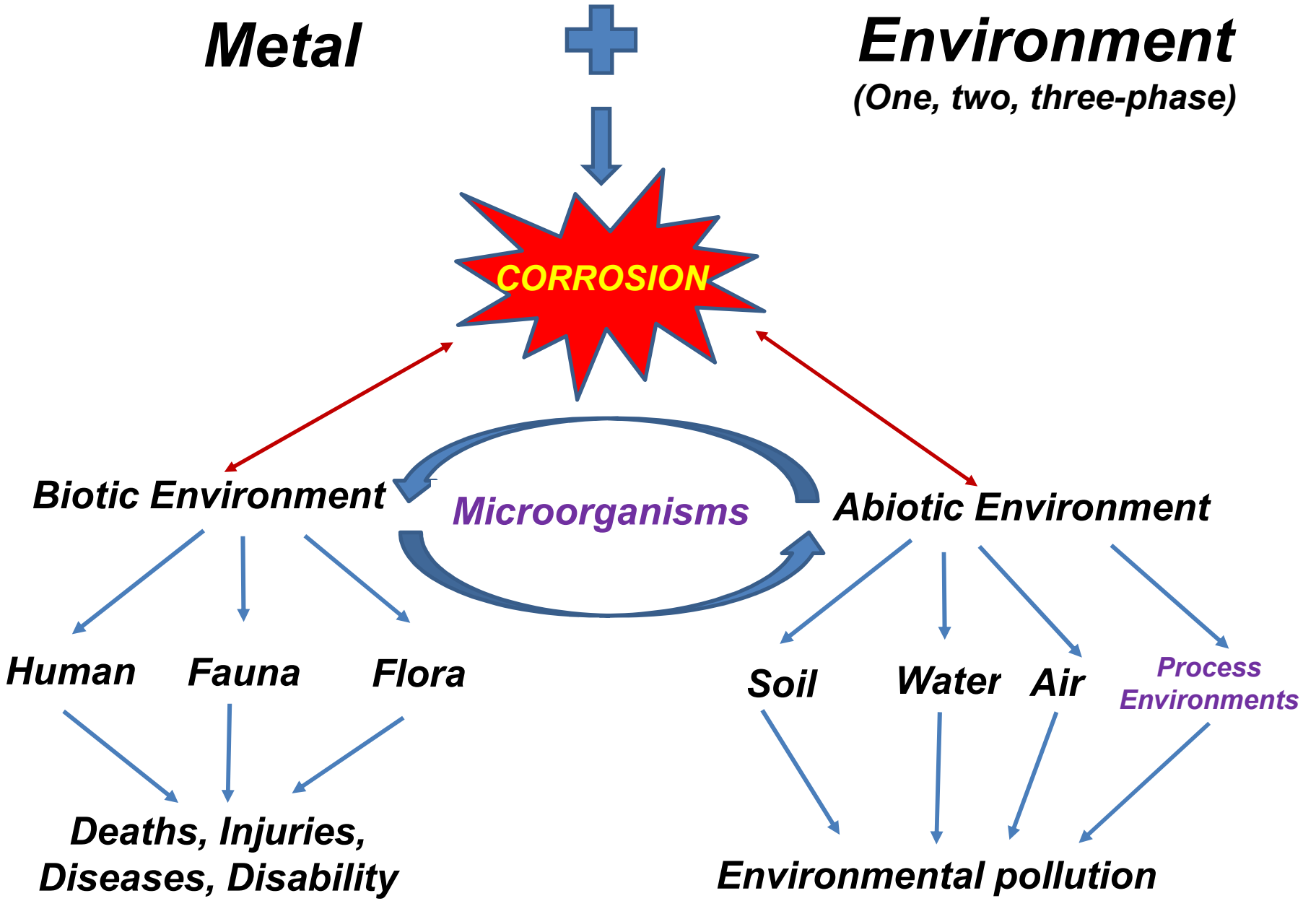


Materials suitable under specific conditions.

CORROSION MANAGEMENT –
planning actions for the selection, design, corrosion mitigation, prevention, monitoring, and prediction

Chemical thermodynamics and kinetics are decisive subjects (instruments) that define factors in materials deterioration and prediction of destruction.

Alec Groysman



Alec Groysman

CORROSION

Fire

Explosion

Release of dangerous chemicals (Toxicity)

Process Safety

Alec Groysman

Process Safety ***- a discipline that focuses on the prevention of fires, explosions, and accidental harmful substances and energy releases at chemical process facilities.***

Avoidance and control of reaction heats, flammability, explosiveness, toxicity, corrosiveness and chemical interaction.

Corrosion Management - planning actions of selection, design, corrosion mitigation, prevention, monitoring, inspection, and prediction.

To follow processes safety, suitable materials, design, mitigation measures and corrosion monitoring methods must be used.

Alec Groysman

Safety is the state of being "safe" (from French sauf), the condition of being protected from harm or other non-desirable outcomes.

Safety can also refer to the control of recognized hazards (CORROSION!) in order to achieve an acceptable level of risk.

Due to the flammability, toxicity and explosion hazard of most substances used in chemical industry, they are classified as dangerous (harmful) substances, which means it is subject to strict reporting requirements in the event of a spill or discharge.

All corrosion phenomena relate to Process Safety!

But in different manner !

Failure of coating, 2 years. Pipeline with water (90°C) in the atmosphere.

Titanium tubes contact carbon steel baffles in cooling water, 4 years.

Hydrogen embrittlement of CS, medium - H_2 at 280°C (with peaks to 380°C) and 46 bar; 16 years

Human error and poor management control!

Not only technical corrosion issues but human response and actions.

Alec Groysman

CORROSION FAILURES

Failure is a sudden cessation of functioning, or a lack or deficiency of a desirable quality.

Oil Refinery Haifa

Aboveground Storage Tank

700 oil refineries and 150 types crude oils over the world.

250 chemical enterprises in Israel.

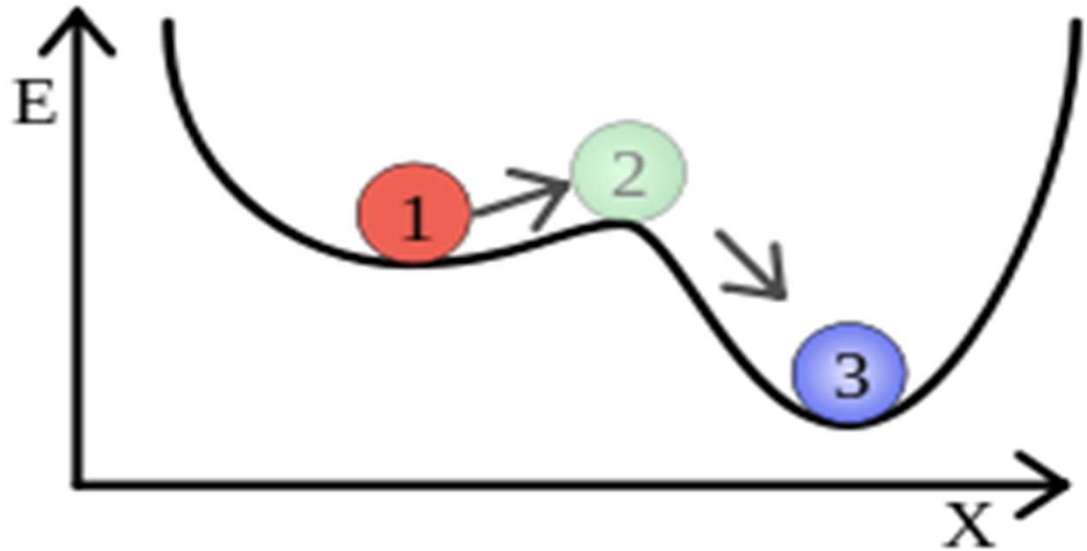
Long underground and aboveground pipelines.

The aging of equipment and constructions, wide variation in crude oil type, high corrosivity of media and harsh technological parameters result in high corrosion risks.

Alec Groysman

Why do corrosion failures occur?

1.Corrosion phenomena - stochastic processes.



Difference between stable (1 and 3) and 'metastable' (2) state.
E – energy of a system.
X – the direction of the reaction.

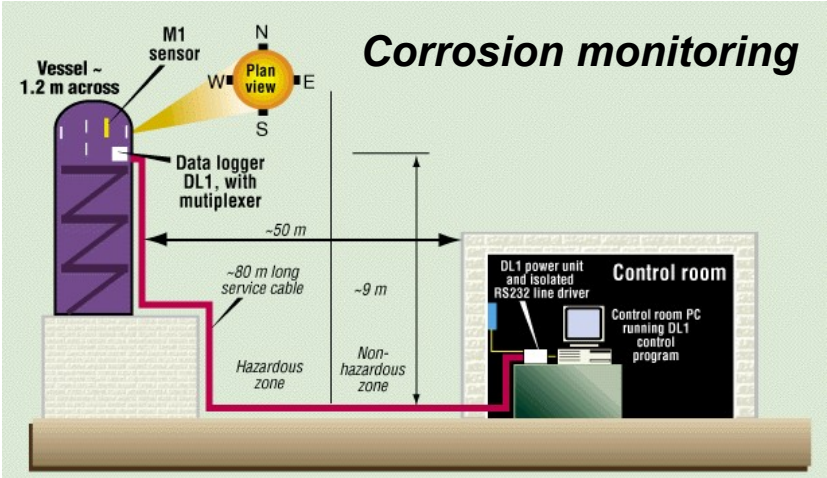
There are no satisfactory kinetic models ...

Alec Groysman

2. *The corrosion phenomena depend on many inner (metal) and outer (environment) factors*

3. *Anti-corrosion measures do not guarantee full prevention/protection from failure. Mitigation! ΔS > 0 !*

4. *Corrosion monitoring methods do not completely reflect real situation.*



Alec Groysman

5. Insufficient Corrosion Management

Standards, codes, specifications, rules, guidelines, and knowledge are not effectively used.

Specialists are often not familiar with existing literature, experience, and achievements of others.

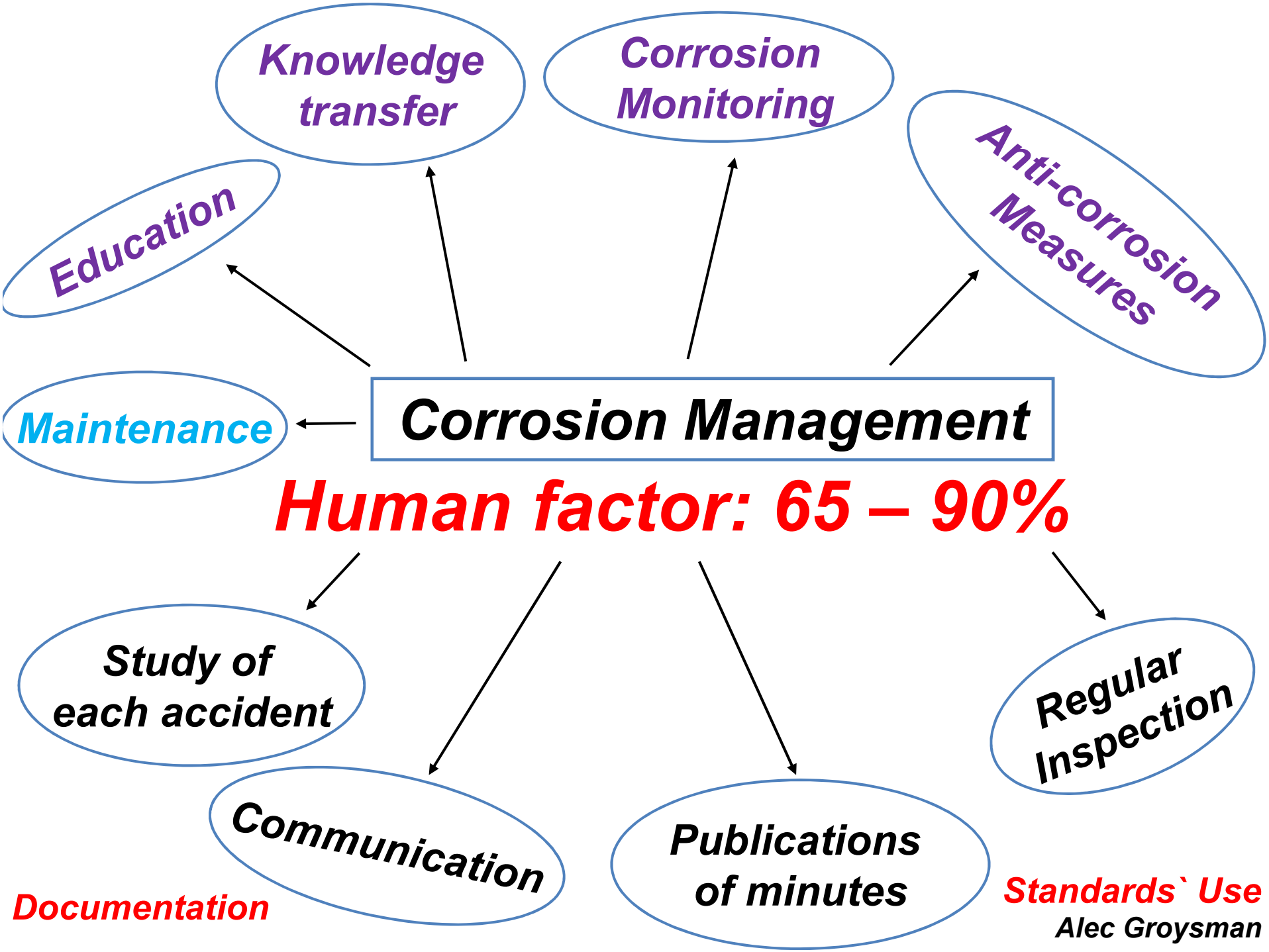
Control and monitoring measures, inspection are not always carried out on a regular basis and in time.

About 30% of corrosion accidents are not registered.

The Human Factor plays a Vital Role!

The reasons of humans` mistakes:

- ***Lack of knowledge, education, and training.***
- ***Incorrect design. Insufficient design review.***
- ***Wrong operation (maloperation).***
- ***Insufficient control and supervision.***
- ***Lack of incentives to reduce corrosion risk.***
- ***Element of change and lack of communication.***
- ***Inattention to warnings/technical information.***



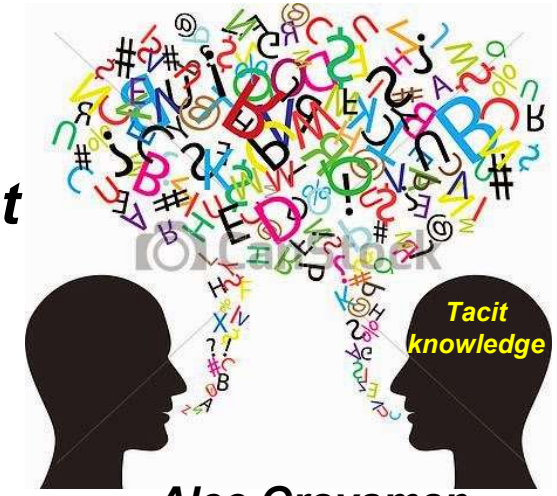
Alec Groysman

Legislation in the field of corrosion management (Proposal)

To establish penalties
for the lack of anti-corrosive preventive actions and corrosion monitoring.

Education and Knowledge Transfer

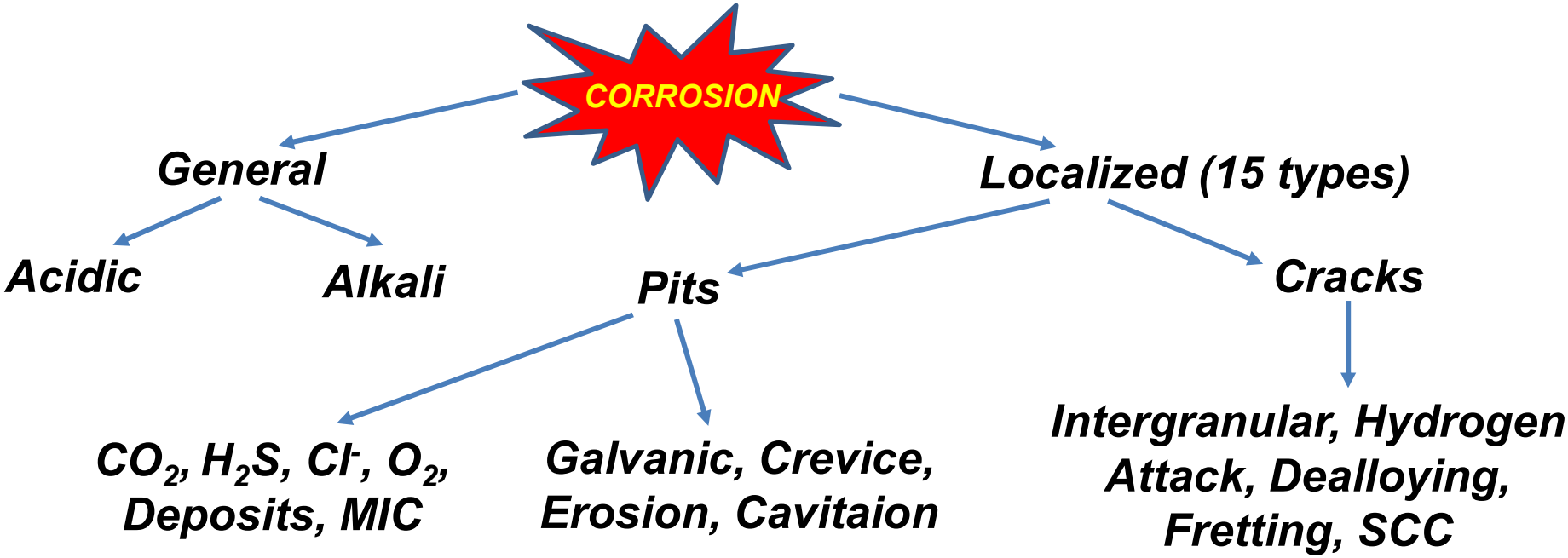
75% of all corrosion failures happen because of insufficient information, communication, interaction, and knowledge.



Alec Groysman

Corrosion Assessment Using Corrosion Modelling

The purpose of a corrosion assessment is to identify the corrosion hazards by defining the corrosion type, mechanism and expected uniform or localized corrosion rate without mitigation measures.



Passivity. Passive films. Models?

Specific corrosion phenomena in chemical industry?

Dew Pont Corrosion. Corrosion Under Thermal Insulation. Fouling?

The next step in corrosion assessment is to define corrosion mitigation strategy and forecast corrosion rate of protected construction.

Prediction ?

Alec Groysman

Critical chloride (Cl^-) concentrations in water for different stainless steels without pitting corrosion

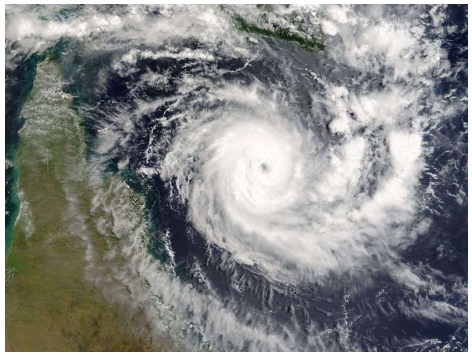
Alloy	Critical chloride concentration, ppm	Reference
SS 304	180	R.A. White, E.F. Ehmke, 1991
	500	C.P. Dillon, 1995
SS 304L	100	J.C. Tveberg, 2005
SS 316	500	R.A. White, E.F. Ehmke, 1991
	3,000	C.P. Dillon, 1995
SS 316L	500	J.C. Tveberg, 2005

Alec Groysman

How to predict and prevent (decrease) failures?

1. ***Corrosion Management culture.***
2. ***Activities:***

- ***Safety always starts with correct engineering anti-corrosion design.***
- ***Forcing managers to establish penalties and incentives.***
- ***Legislation in the field of corrosion management !***
- ***Searching how chaotic corrosion processes result in failure.***
- ***To create models similar to weather models.*** ***Big Data!***

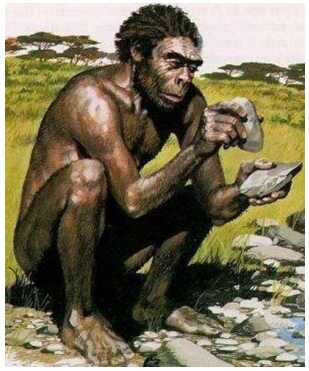


Weather - constantly changing state of the atmosphere.

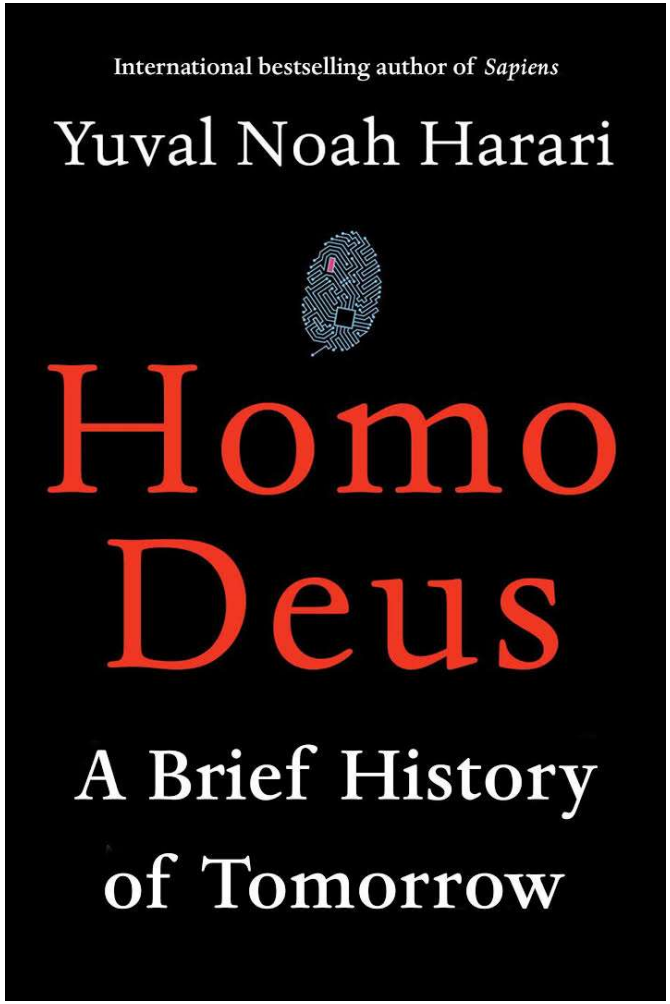
Corrosion - constantly changing state of a metal – environment system.

Degree of uncertainty will remain.

Alec Groysman



Homo sapiens is the only species on earth capable of cooperating flexibly in large numbers



Alec Groysman

COLLABORATION is CRITICAL !

Process Safety Management + Corrosion Management

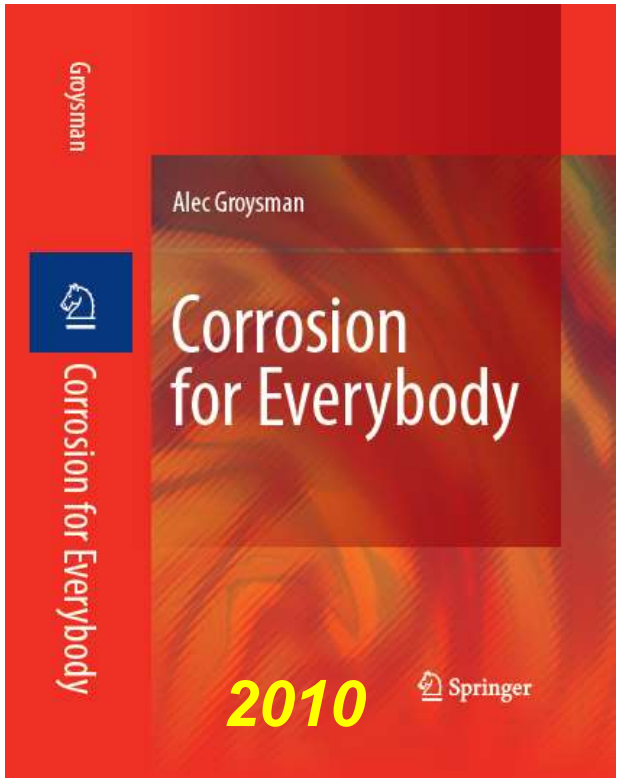
Safety and Corrosion should be of concern to everyone: employer, employee and contractor.

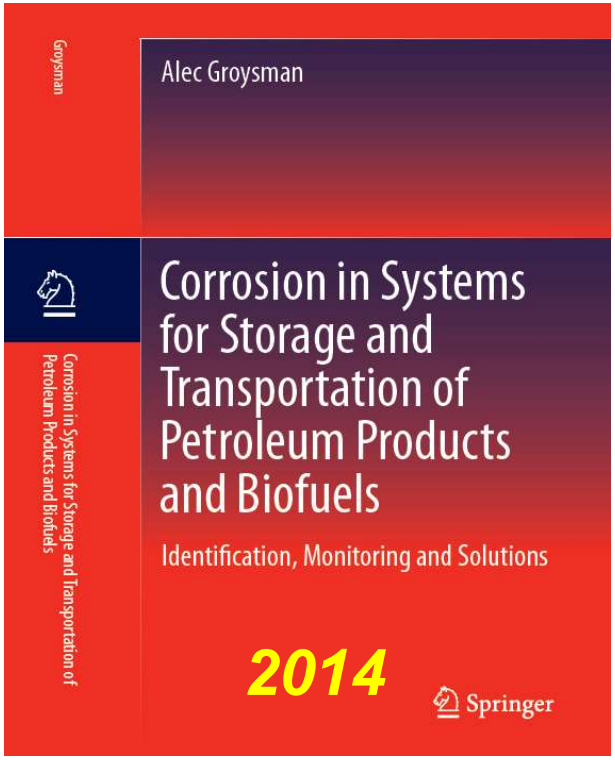
Safety and Corrosion culture: Competence, Control, Communication.

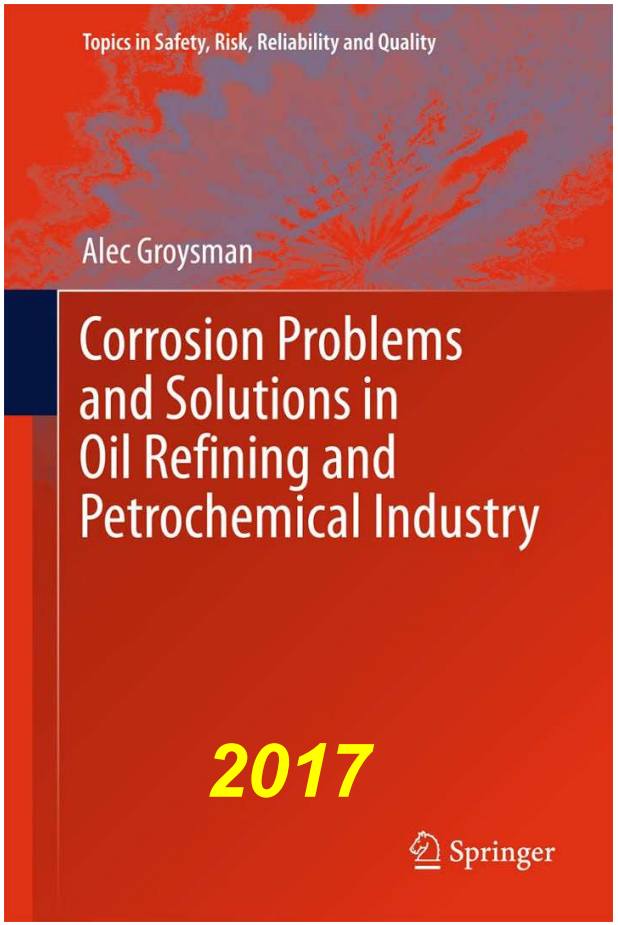
Safe and healthy world (chemical and other industries)

Alec Groysman

PREVENTION IS BETTER & CHEAPER THAN A CURE







Alec Groysman