COST Action TU 0601
Robustness of structures

- PRINCIPLES -
Acceptance Criteria
for robustness assessment

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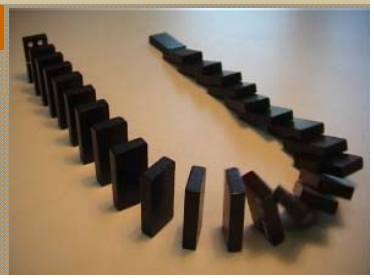


Assessment criteria

From Regulatory viewpoint:

acceptance criteria should be fixed in order to prevent a negative balance for the society

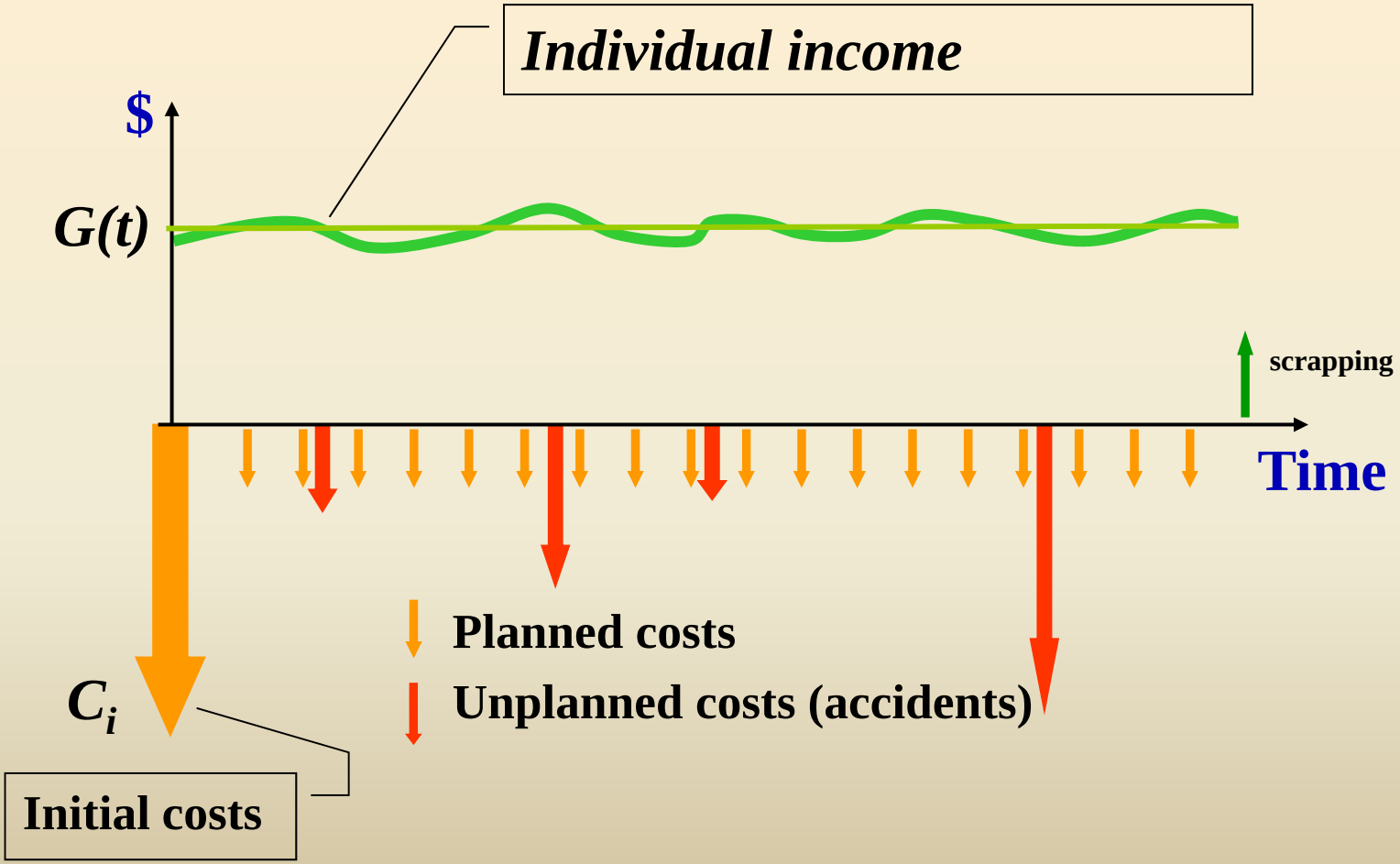
expected benefits to society – exp. losses ≥ 0

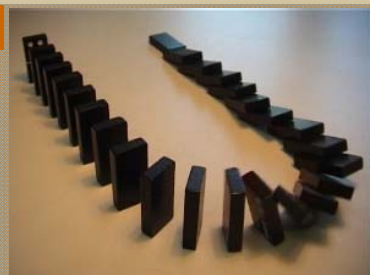
From the viewpoint of a private actor (owner):

Personal profit (= p. gain – expected p. loss) to be maximum

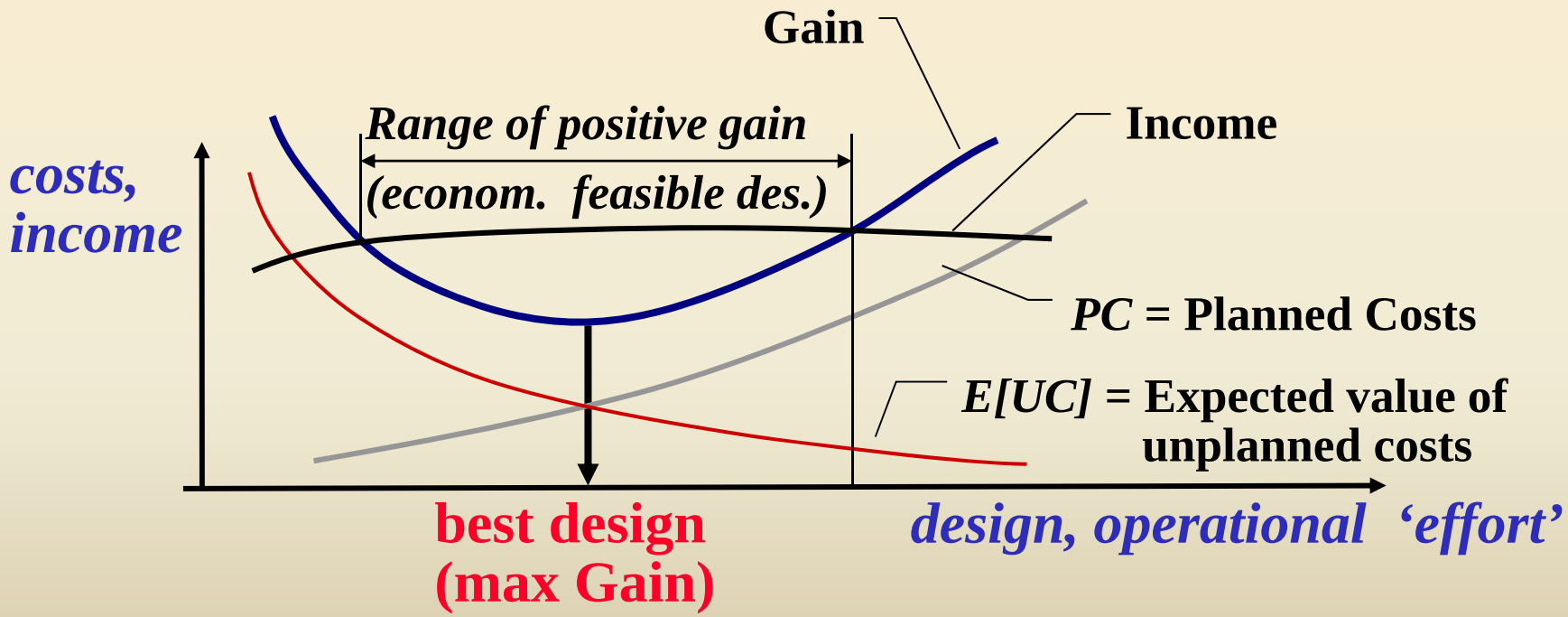
Issue is optimisation. Where to allocate the money in order to get the max advantage.

Gains and losses (private viewpoint)



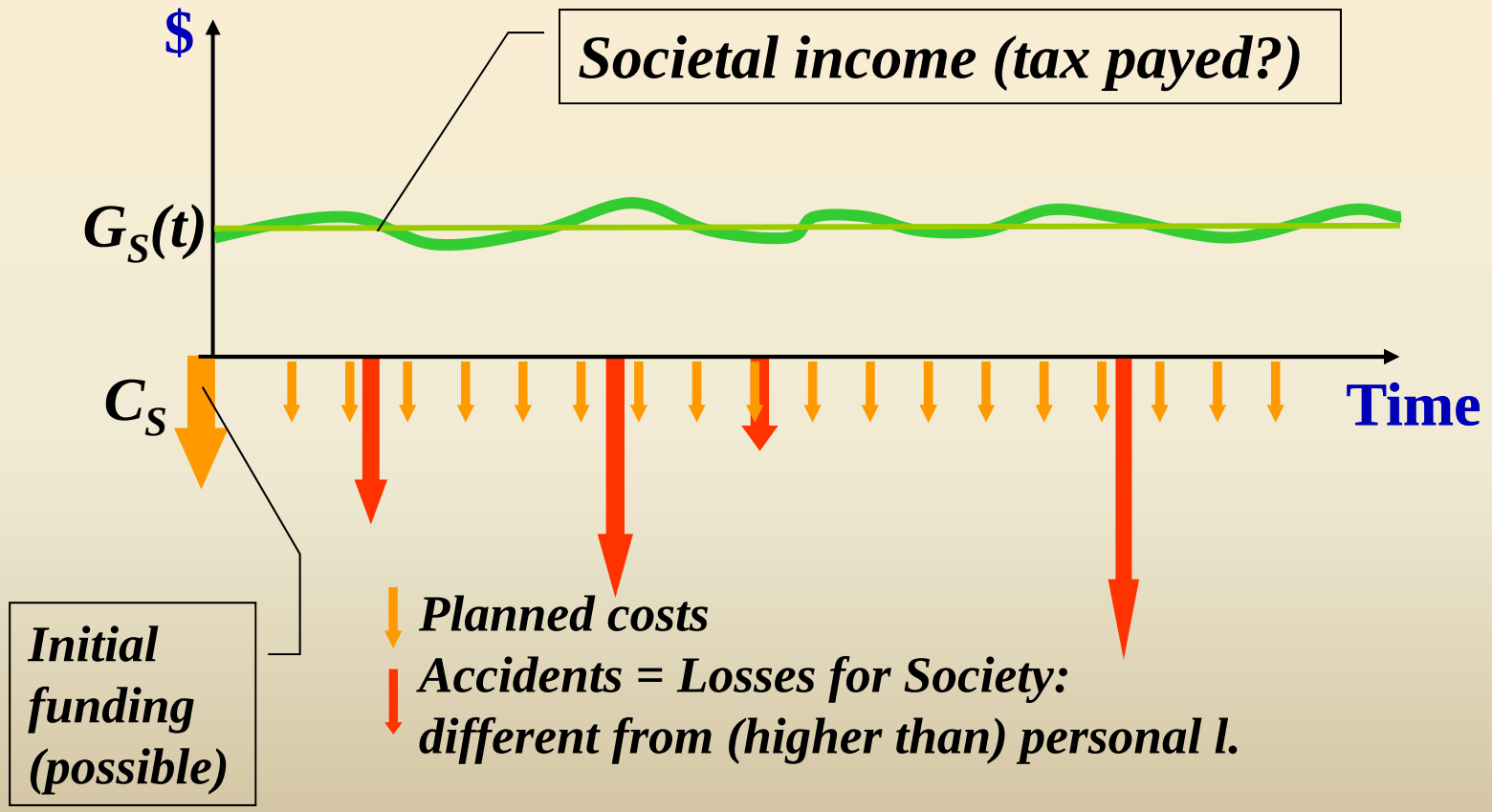


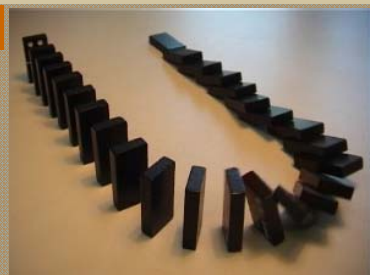
Individual optimisation



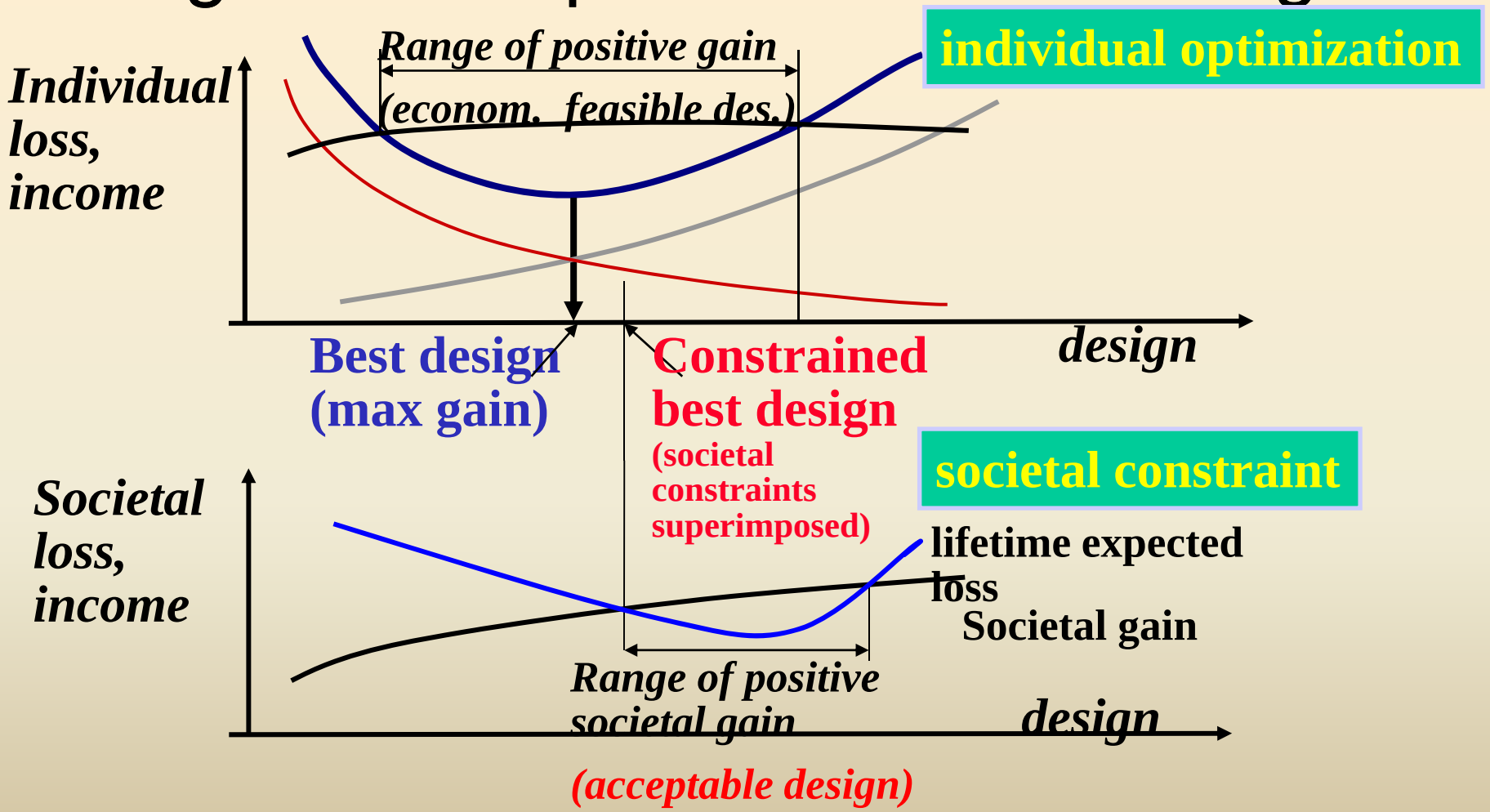
The optimal decision is the one that selects the largest expected utility

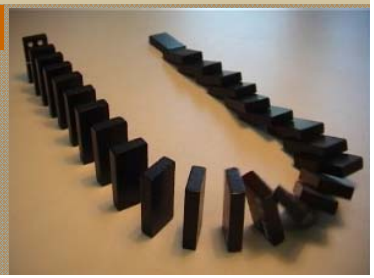
Gains and losses (societal interest)



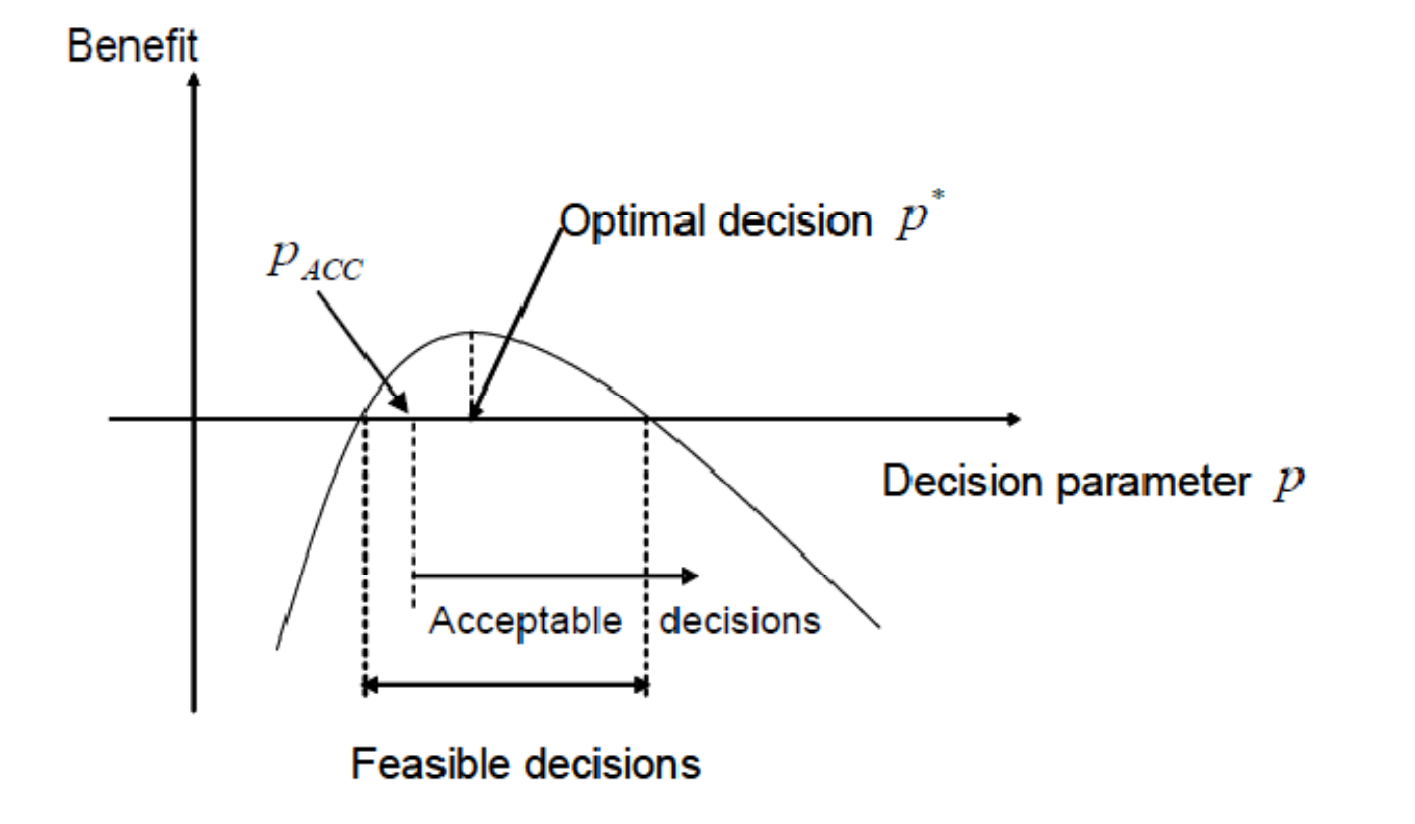


Design with respect also to societal gain

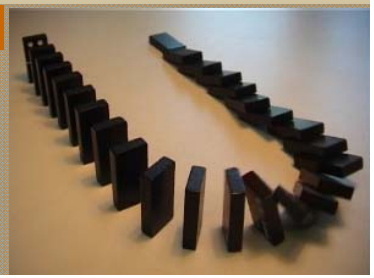




Constrained optimisation



From JCSS (2008): Risk Assessment in Engineering Principles, System Representation & Risk Criteria



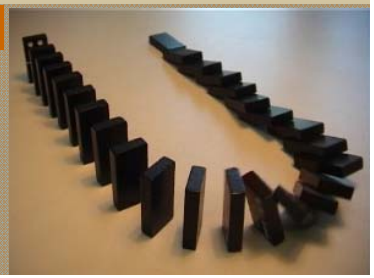
Need for a omnnicomprehensive balance

Performing the cost-benefit analysis from a societal viewpoint (in order to apply the positive balance acceptance criteria implies a proper consideration of all the terms of the balance itself.

In particular it is important to account for all (negative) consequences of an activity, to be measured in a unique unit (generally: money) for all types of scenarios.

Consequences can be classified according to:

- the item affected:
- the probability of occurrence:
- the distance in space and time from the initiating event



Consequences (categories)-1

Tangible assets

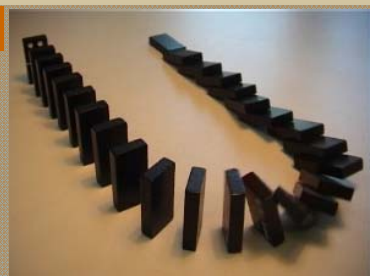
Damage: partial loss of functionality
Failure: total loss of functionality
Physical Loss: [ex: sinking of a ship]

Regarding

Structural elements /whole structural system
Other elements/systems (e.g. plants)
third parties assets

Intangibles

Deferred production
Cost of investigation/lawyers
Loss of opportunities /reputation
Share prices/ market share



Consequences (categories)-2

- Persons

Injuries		crew/employees
Sickness	*Regarding*	clients/users/passengers
Fatalities		third parties

- Nature

Release of toxic pollutants

Green House Gases emissions

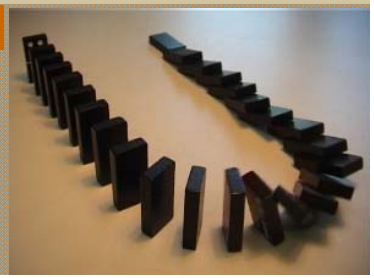
Loss/modification of bio-diversity

- Probability of occurrence

systemic (P=1)

occasional (P<1)

rare (P<<1)



Consequences (direct - indirect)

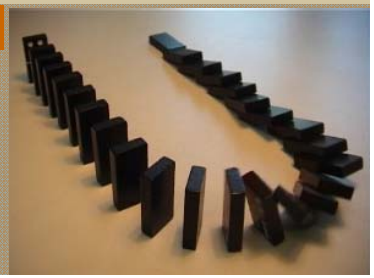
- direct

  all marginal (not considering loss of system functionality) consequences associated with damages or failures of the constituents of the system (JCSS)

- indirect

  all the others

Note this establishes a difference between those consequences that are somehow confined in space and time close to the initiating event and those which are more long-ranging



Analysis of interactions in time & space

- In space

ship crew oil field (workers) Ocean area earth

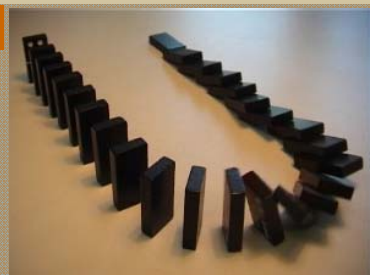
space

- In time

material fabrication design construction operation dismantling recycling

time

Life-cycle assessment



Sectorial applications of the balance (1)

Sometimes specific items of the balance are considered, focusing on single aspects.

Typical case: assessment of a proposed updating of a Norm devoted to increase safety (decrease risk for persons).

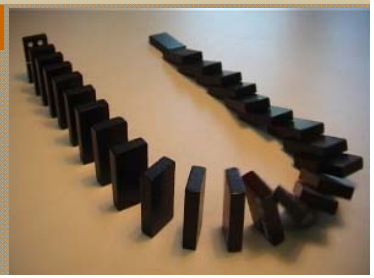
Example of acceptance criteria:

Cost to Avert a fatality (CAF) = ratio Cost / benefit

<

Societal Willingness To Pay (SWTP)

[empirical, established practices]



Sectorial applications of the balance (2)

A much more objective criterion for acceptance can be based on the Life Quality Index LQI which is based on macro socio-economic indicators:

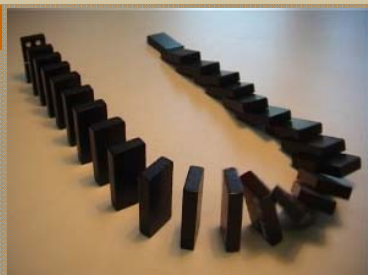
- Gross National Product (pro-capite)
- Life expectancy
- Proportion of life spent working for living

Criterion: $\Delta(LQI) > 0$ (increase in the LQI)

JCSS 2008 Risk Assessment Engineering Principles, System Representation & Risk Criteria Background documents

#4 The philosophy behind the Life Quality Index and Empirical Verifications by Rackwitz,R.,

#5 Optimisation with a Life Quality Index Acceptance criterion by Rackwitz,R.,

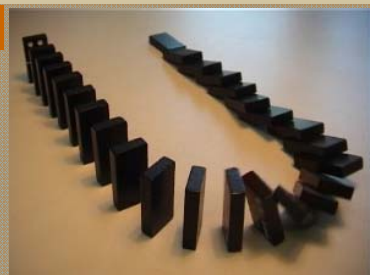


CONCLUSIONS

- Acceptance criteria for robustness are to be seen as a particular aspect of acceptance criteria in assessing any human activity → all features of rational decision making are to be recalled in the context of robustness evaluations.
- need for a complete and truly holistic assessment of all the societal risks and benefits
- combination of the above terms related to societal preferences into a unique scalar utility function.
- a powerful means to relate economical aspects and live-saving design criteria is represented by the Life Quality Index, based on objective macroeconomic indicators at national level.

Potentiality of including environmental risks.

Final acceptance criteria expressed as positive variation of the index itself.



CONCLUSIONS

At the moment, formulation of acceptance criteria on robustness issues in present structural Norms in the form of deterministic checks (column removal, minimum tie and connection forces) implicit criteria [practical solution for an easier implementation of the robustness requirement in standard designs]

Also depending on the evolution of the quantitative definitions of Robustness, implementation of databases may in the future provide guidelines

However, the bases of these types of formulations of requirements are empirical and a proper calibration based (as much as possible) on holistic cost-benefit balance is considered as a necessary step forward [calibration by explicit methods]