OCCUPATIONAL RISK MODEL AND THE ORM TOOL

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Occupational Accidents a Serious Concern

Accidents at work in industry:

- Kill 1 person every 2 hours
- Injure 1 person every 5 seconds [Eurostat, 2004]
- In EU-15 in 2001 the death toll was approximately 4.900 every year out of 7.6 million accidents (4.9 million resulted in more than 3 days of absence) [Eurostat 2004].
- The number of fatalities at work has risen in the EU-27 to 7.460 a year.
- In Greece occupational accidents result in about 100 deaths per year
- In the Netherlands the toll rises to 80 deaths per year.

The WORM project

Occupational Risk Management

- Risk Management means the selection of specific actions that will change the working environment so that occupational risk is reduced.
  - Limited resources; time, money etc.

- To manage risk we have to measure it. Because we cannot manage what we cannot measure

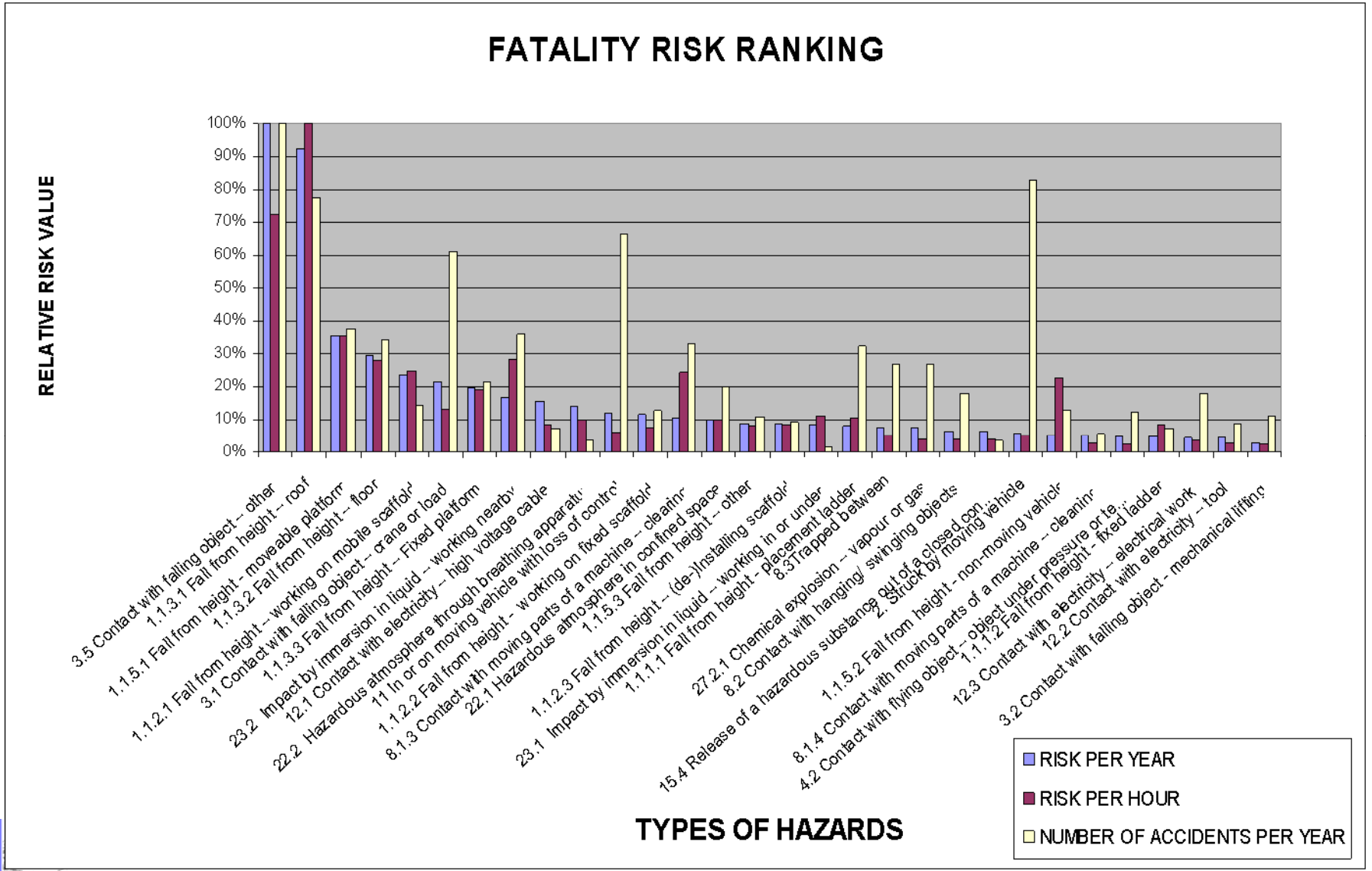
Risk of Occupational Accident

- Probability that during a specified period in the future the worker will suffer an accident with specific bodily harm.
- Possible Consequences
  - Recoverable Injury
  - Permanent Injury
  - Fatality
  - OK
- Probability of each consequence
- Accidents occur randomly in time.
- **Exposure** to the hazard is important. The more the riskier.
- Poisson Random Process: Constant risk rate

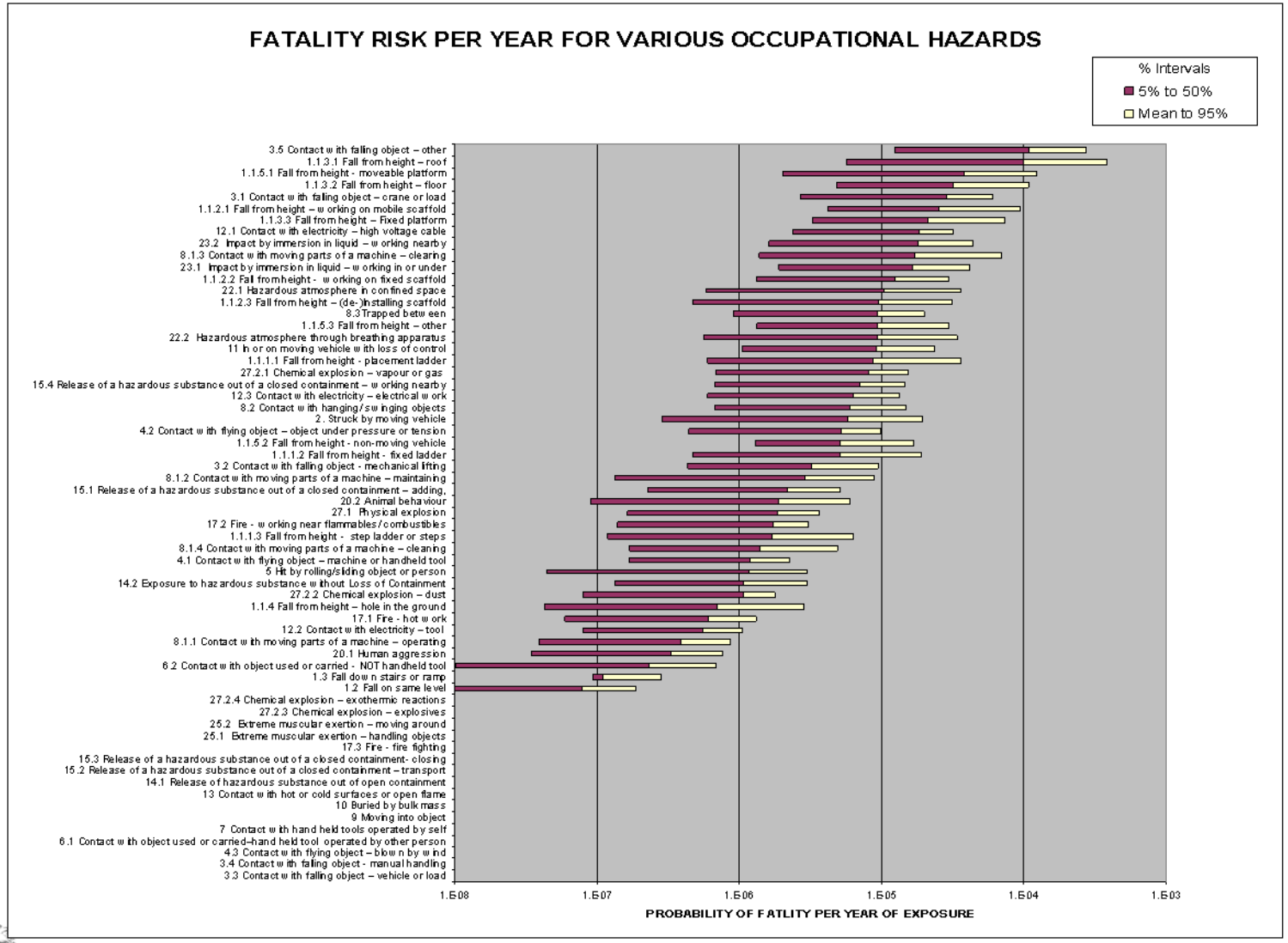
Quantitative risk indices

- **Risk Rate**: Probability of an accident per unit of time.
- **Risk per year**: Probability of an accident during a year for the average worker (mean yearly exposure).
- Risk can be calculated if risk rate is known and if exposure is known and it always refers to the future.

Risk Ranking



Risk Variability



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LINKING ACCIDENT ROOT CAUSES TO RISK

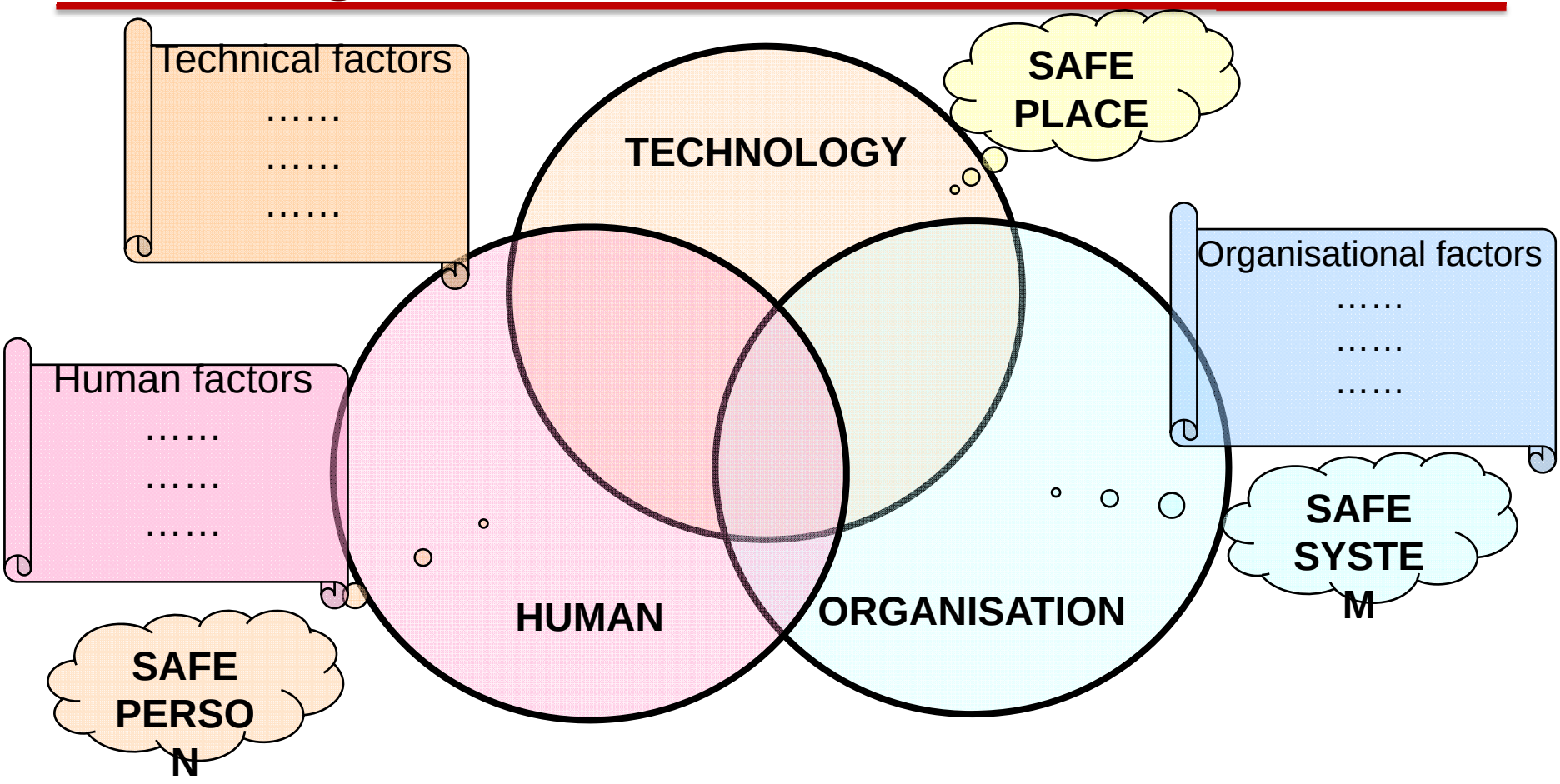
- QUANTIFICATION OF OCCUPATIONAL RISK ONLY PARTIALLY ANSWERS THE QUESTION OF RISK MANAGEMENT (MANAGING EXPOSURES E.G. LADDER VERSUS SCAFFOLD)

- DETERMINIG RISK REDUCING POLICIES THAT CAN BE QUANTIFIED IN TERMS OF THEIR EFFECT ON RISK IS NOT EASY AT THIS LEVEL

- DEVELOPMENT OF **DETAILED MODEL** IN ORDER TO IDENTIFY CAUSES AND OTHER FACTOR INFLUENCING THE OCCURRENCE OF ACCIDENTS IS NECESSARY

- THEN RISK REDUCING ACTIONS (MEASURES) CAN BE DEFINED AS SPECIFIC ACTIONS INFLUENCING THE UNDERLYING CAUSES AND OTHER IMPORTAN RISK SHAPING FACTORS.

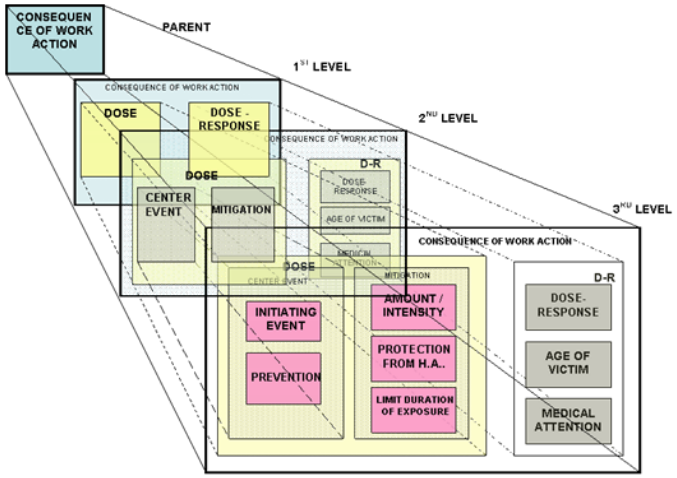
Working Environment

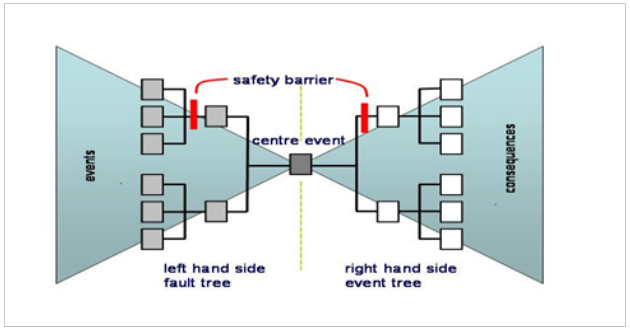


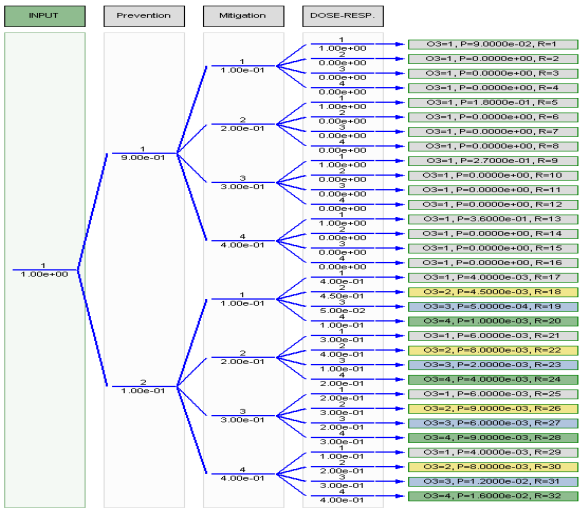
ROOT CAUSES OF ACCIDENTS CAN BE FOUND IN ANY AND ALL OF THESE THREE ARAEAS

DEVELOPMENT OF LOGIC MODELS

- DEVELOPMENT OF A MODEL TO SIMULATE THE LOGICAL INTERCONNECTION OF VARIOUS FACTORS INFLUENCING THE OCCURRENCE OF ACCIDENTS







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LOGICAL MODEL, BOWTIE

EXPERIENCE
HORRIBLE STORIES
About 9113 accidents in a period of six years in GISAI

STORY BUILDER

SCIENTIFIC/ TECHNICAL KNOWLEDGE
COMMON SENSE
ADDITIONAL EXPERIENCE

MANAGEMENT INSIGHTS/ASPECTS

ORGANIZE INFORMATION

- INITIATING EVENTS
- SAFETY FUNCTIONS
  - PRIMARY BARRIERS
  - SUPPORT BARRIERS
  - PIEs
- DEPENDENCES
  - STRUCTURAL
  - PROBABILISTIC
- CENTER EVENT (output)

From Story Builder To Bowtie

LOGICAL MODEL

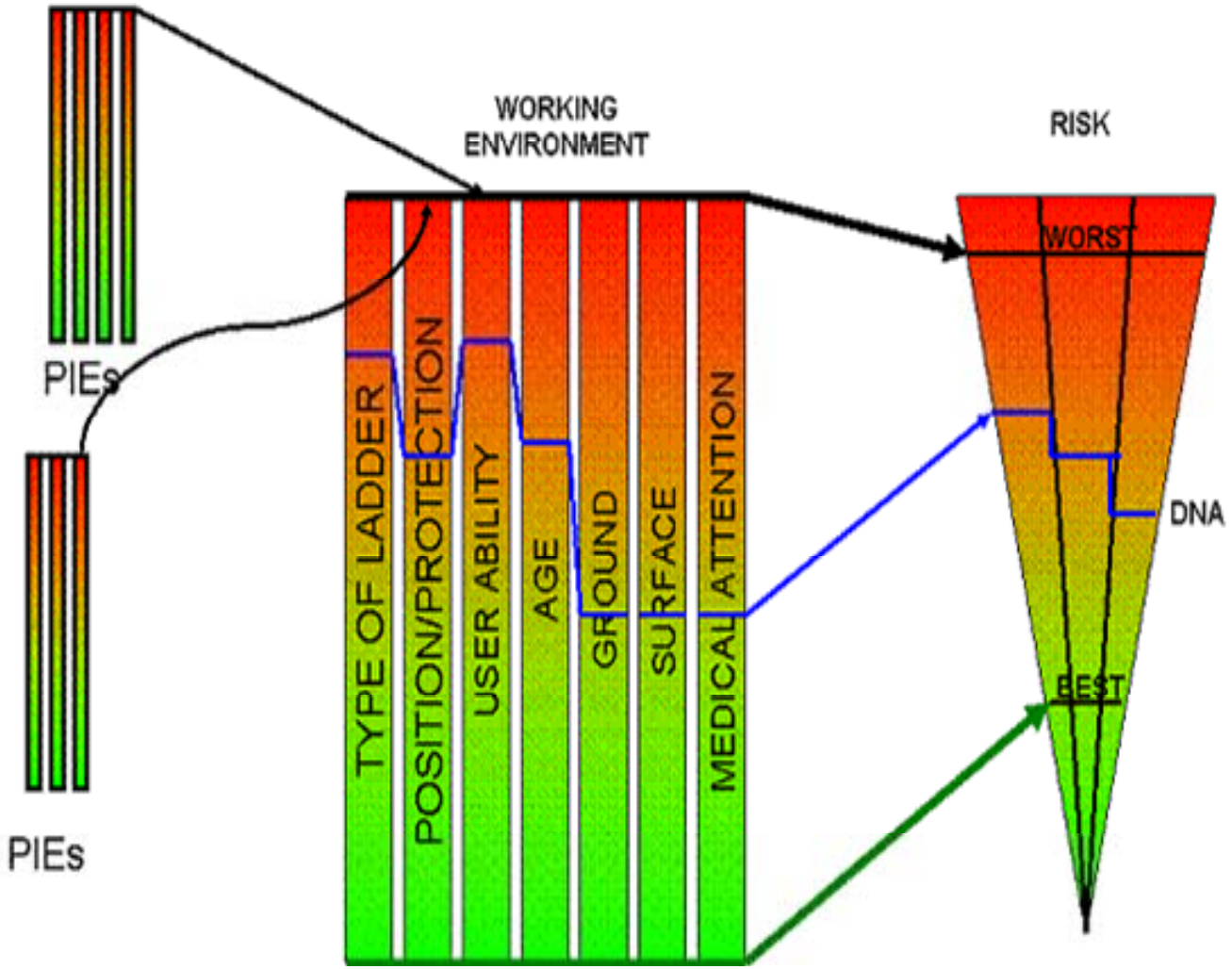
Software to b
Bowtie

QUANTITATIVE RISK ANALYSIS

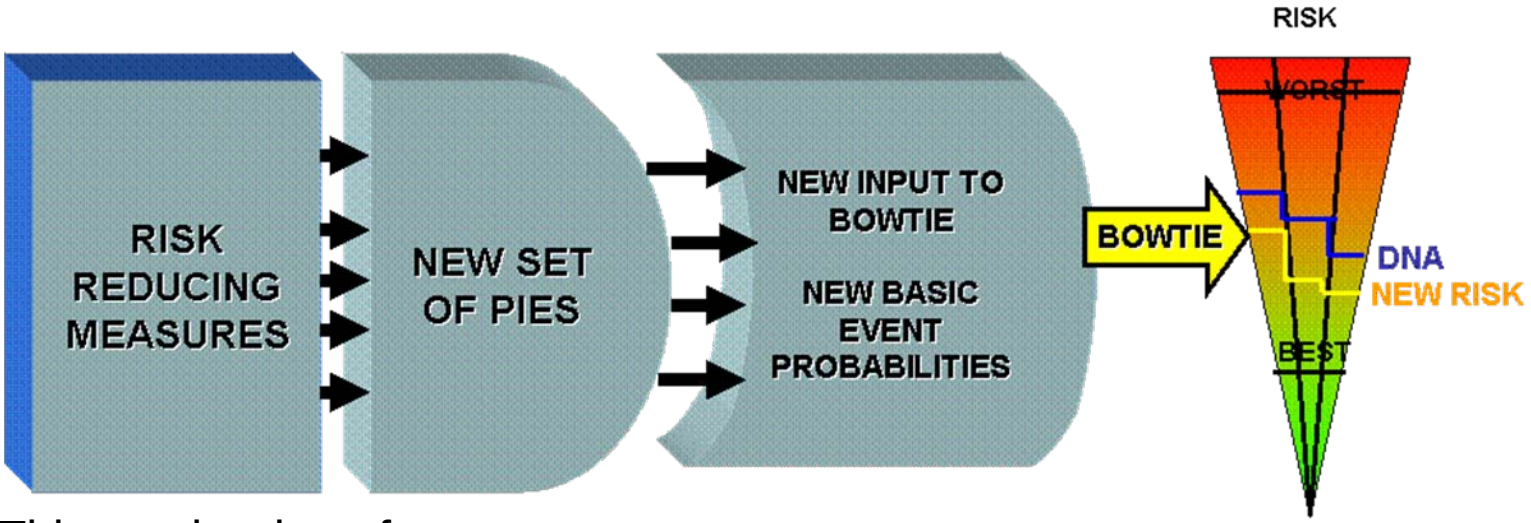
- Sixty three logic models have been developed (one for each hazard)

- The logic models have been quantified on the basis of:
  - Number of accident sequences observed in the Netherlands (GISAI)
  - Assessment of Working Conditions (PIEs) through a nationwide survey.
  - This quantification provides the Dutch National Average (DNA)

Probability Influencing Entities (PIEs)
Safety Barriers and Logical model



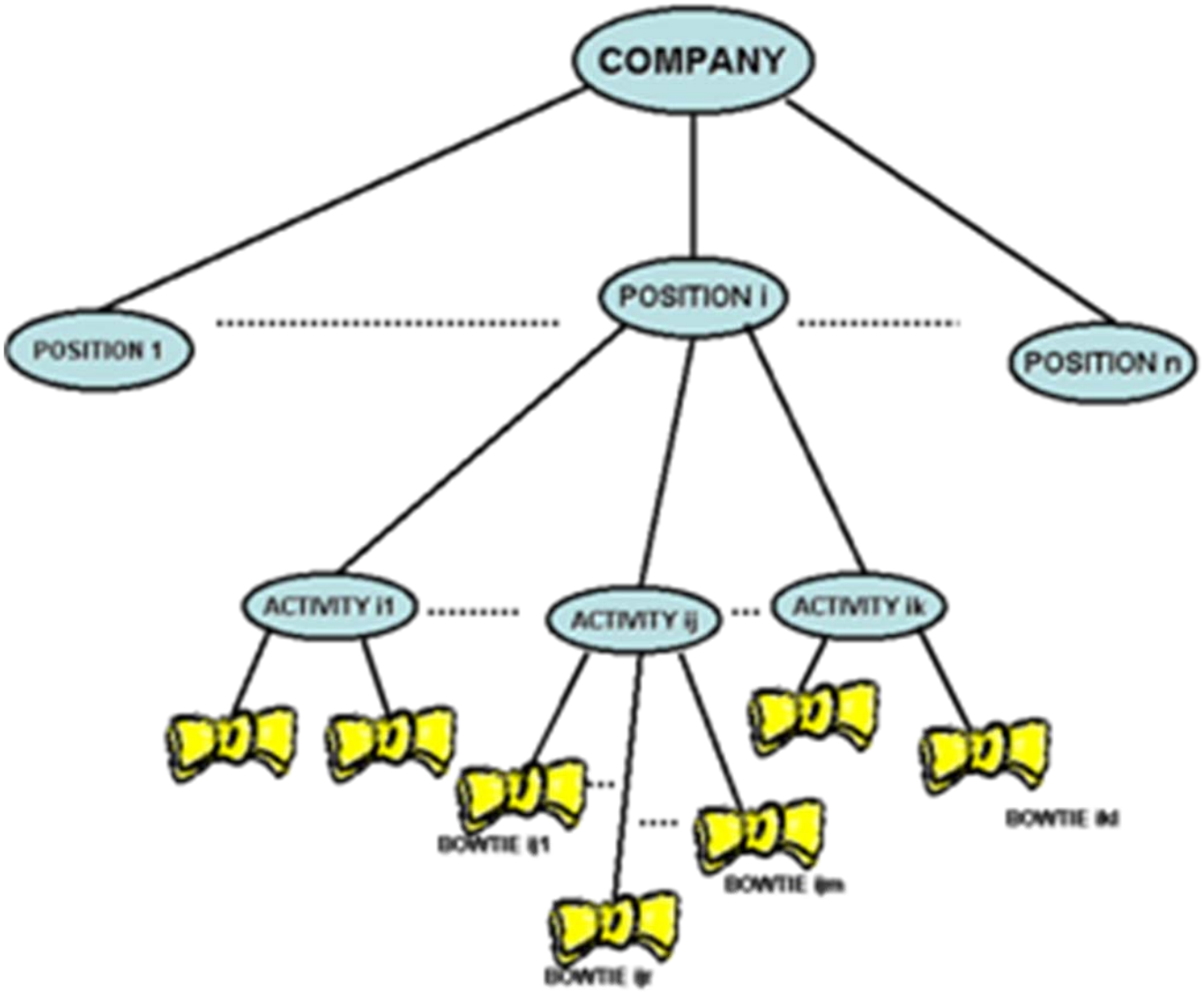
RISK MANAGEMENT



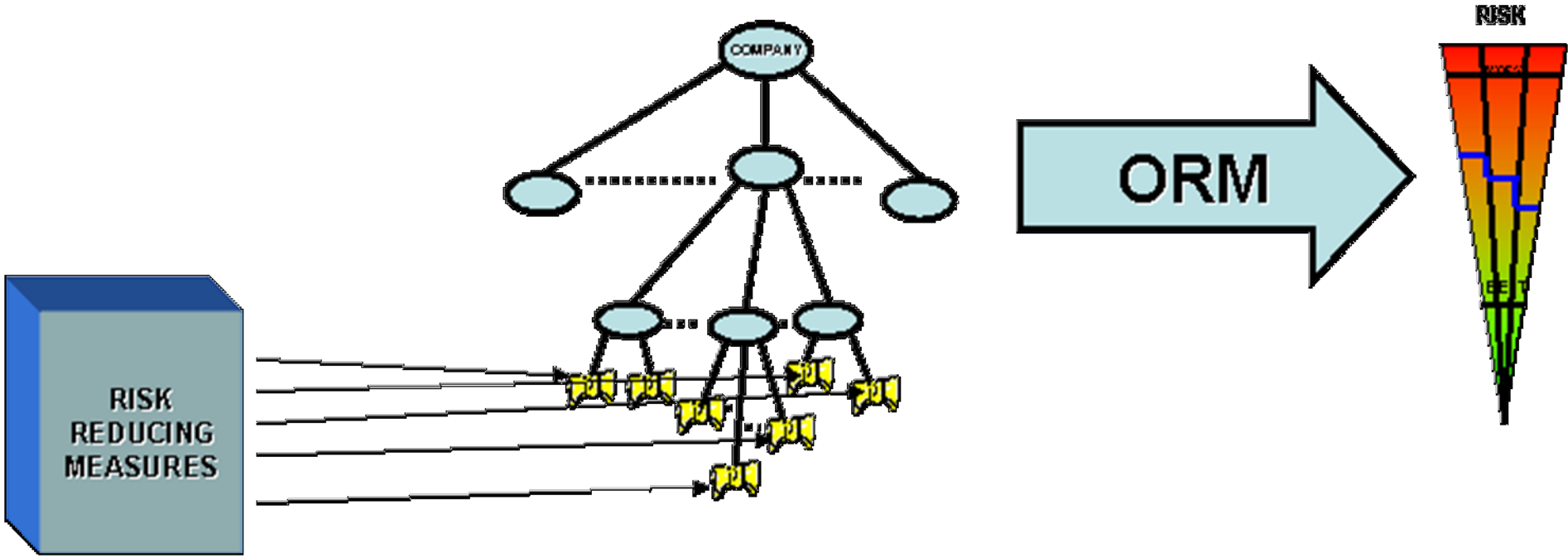
•This can be done for:

- a single hazard
- a particular job type (combination of hazards and exposures)
- •a particular work place with different types of jobs.
- •SELECT FROM A LIST OF 350 RISK REDUCING MEASURES

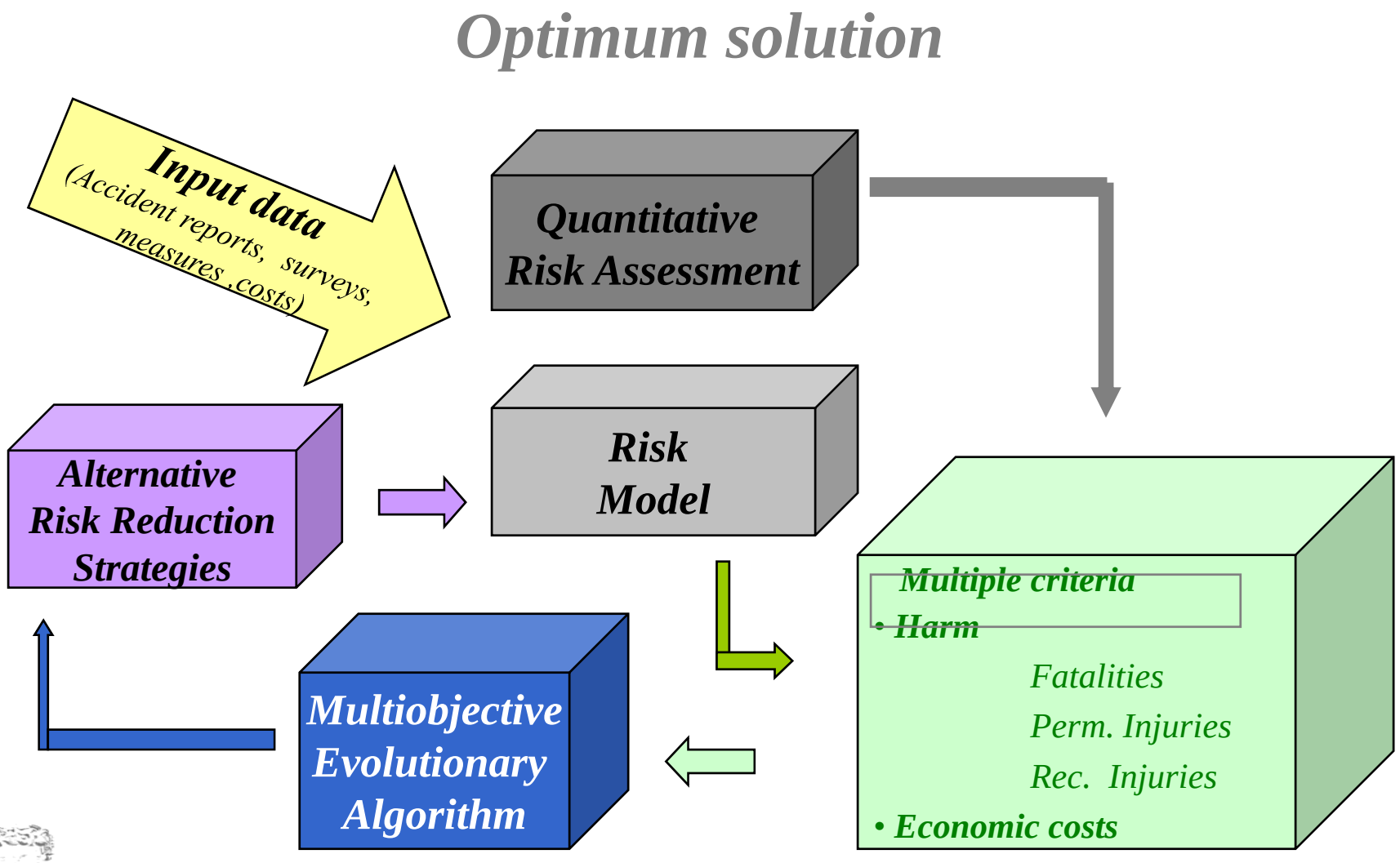
COMPOSITE MODEL



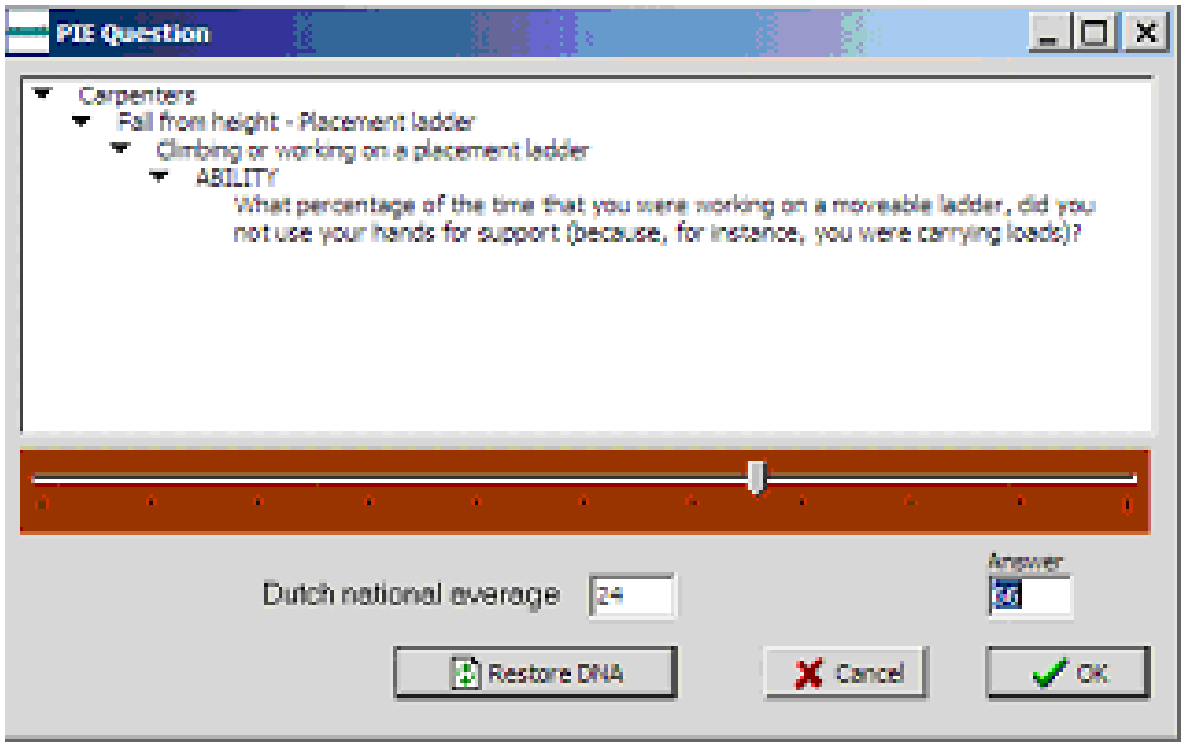
RISK REDUCING MEASURES --- MULTIPLE HAZARDS



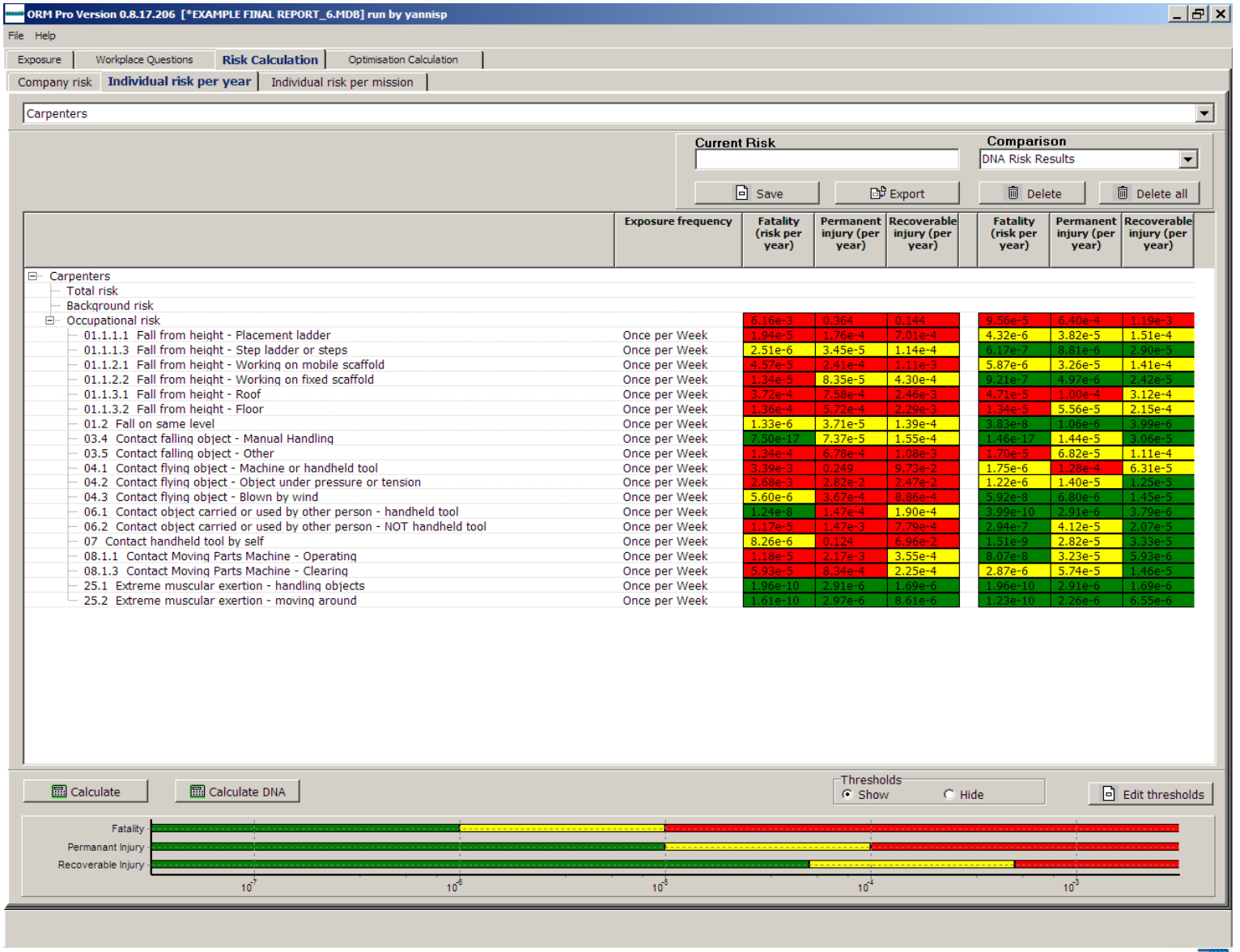
Multiobjective Risk Optimization



Customising Working Environment

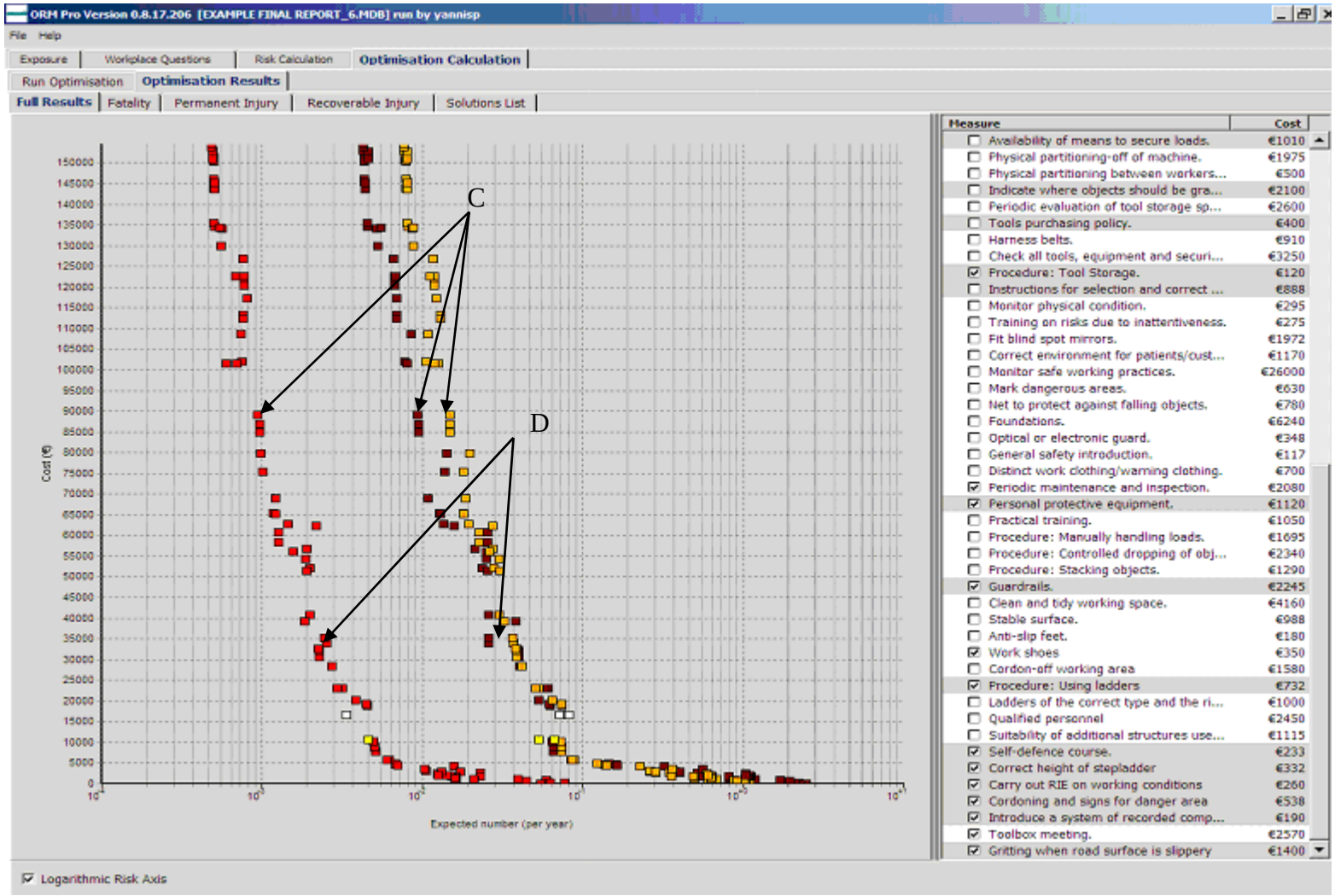


Individual risk per year for each job and hazard type



	Exposure frequency	Fatality (risk per year)	Permanent injury (per year)	Recoverable injury (per year)	Fatality (risk per year)	Permanent injury (per year)	Recoverable injury (per year)
Carpenters							
Total risk							
Background risk							
Occupational risk		6.16e-3	0.364	0.144	9.56e-5	6.40e-4	1.19e-3
01.1.1.1 Fall from height - Placement ladder	Once per Week	1.94e-5	1.76e-4	7.01e-4	4.32e-6	3.82e-5	1.51e-4
01.1.1.3 Fall from height - Step ladder or steps	Once per Week	2.51e-6	3.45e-5	1.14e-4	6.17e-7	8.81e-6	2.90e-5
01.1.2.1 Fall from height - Working on mobile scaffold	Once per Week	4.57e-5	2.41e-4	1.11e-3	5.87e-6	3.26e-5	1.41e-4
01.1.2.2 Fall from height - Working on fixed scaffold	Once per Week	1.34e-5	8.35e-5	4.30e-4	9.21e-7	4.97e-6	2.42e-5
01.1.3.1 Fall from height - Roof	Once per Week	3.72e-4	7.58e-4	2.46e-3	4.71e-5	1.00e-4	3.12e-4
01.1.3.2 Fall from height - Floor	Once per Week	1.36e-4	5.72e-4	2.29e-3	1.34e-5	5.56e-5	2.15e-4
01.2 Fall on same level	Once per Week	1.33e-6	3.71e-5	1.39e-4	3.83e-8	1.06e-6	3.99e-6
03.4 Contact falling object - Manual Handling	Once per Week	7.50e-17	7.37e-5	1.55e-4	1.46e-17	1.44e-5	3.06e-5
03.5 Contact falling object - Other	Once per Week	1.34e-4	6.78e-4	1.08e-3	1.70e-5	6.82e-5	1.11e-4
04.1 Contact flying object - Machine or handheld tool	Once per Week	3.39e-3	0.249	9.73e-2	1.75e-6	1.28e-4	6.31e-5
04.2 Contact flying object - Object under pressure or tension	Once per Week	2.68e-3	2.82e-2	2.47e-2	1.22e-6	1.40e-5	1.25e-5
04.3 Contact flying object - Blown by wind	Once per Week	5.60e-6	3.67e-4	8.86e-4	5.92e-8	6.80e-6	1.45e-5
06.1 Contact object carried or used by other person - handheld tool	Once per Week	1.24e-8	1.47e-4	1.90e-4	3.99e-10	2.91e-6	3.79e-6
06.2 Contact object carried or used by other person - NOT handheld tool	Once per Week	1.17e-5	1.47e-3	7.79e-4	2.94e-7	4.12e-5	2.07e-5
07 Contact handheld tool by self	Once per Week	8.26e-6	0.124	6.96e-2	1.51e-9	2.82e-5	3.33e-5
08.1.1 Contact Moving Parts Machine - Operating	Once per Week	1.18e-5	2.17e-3	3.55e-4	8.07e-8	3.23e-5	5.93e-6
08.1.3 Contact Moving Parts Machine - Clearing	Once per Week	5.93e-5	8.34e-4	2.25e-4	2.87e-6	5.74e-5	1.46e-5
25.1 Extreme muscular exertion - handling objects	Once per Week	1.96e-10	2.91e-6	1.69e-6	1.96e-10	2.91e-6	1.69e-6
25.2 Extreme muscular exertion - moving around	Once per Week	1.61e-10	2.97e-6	8.61e-6	1.23e-10	2.26e-6	6.55e-6

Efficient frontier



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SUMMARY AND CONCLUSIONS

- For existing risks for which there is experiential data risk quantification is possible on the basis of
  - Number of accidents;
  - Exposure;
  - Risk Rate;
  - Risk per year;
- Risk Management Policies based on observed number of accidents might not always result in optimum risk reduction.
- Risk Management Policies based on quantified risk indices based on average exposures might also be suboptimal for individual workers and/or groups differing in exposure profiles from the average
- Information existing about the factors determining the work place (technical, human, organisational) can be organised in a logic model to provide the basis of evaluating risk reducing measures.

SUMMARY AND CONCLUSIONS

- Logical models can be developed also for new and emerging risks. Analysis of the relevant technology, human behaviour and organisational aspects of new working environments and situations can be based on the same principles as for logic models of existing risks.
- Quantification of these new models is, however, more difficult. Information about probabilities concerning simple elements of the models might, nevertheless, be deduced from extrapolation of existing data. Other not known probabilities can be assessed through expert judgment and provide the basis of a sensitivity analysis for various alternative risk reducing policies.

Quantified Occupational Risk

THANK YOU
FOR YOUR
ATTENTION