Safety through Organizational Learning (SOL)- an in depth event analysis methodology

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MTO:	Mensch-Technik-Organisation GmbH & Co. Consulting KG *Man-Technology-Organization* Franklinstr. 28 FR 3-8, 10587 Berlin, www.me-te-or.de
FSS:	Forschungsstelle Systemsicherheit *Research Center Systems Safety*
IFV Bahntechnik:	Interdisziplinärer Forschungsverbund Bahntechnik e.V. *Interdisciplinary Research Network Railway Technology*

Where we come from: FSS

→ FSS: Forschungsstelle Systemsicherheit- Research Center Systems Safety at Berlin University of Technology, Institute of Psychology and Ergonomics, Faculty of Mechanical Engineering and Transport Systems

→ Human Factors research for safety and reliability

→ FSS research:

→ Interdisciplinary, world-wide cooperation,

→ Research projects on event analysis, implicit norms, organizational factors, safety culture, knowledge management

What we are doing: MTO

- → MTO is a company which was founded in 2000 by the members of FSS
- → Main business: event analyses, consulting and training
  - → Seminars for safety aspects (culture, leadership) and in depth event analysis
  - → Event analyses for Human Factors

1 Goals of event analyses

How event analyses can be (mis)used

- → Identifying of someone to blame, i.e. someone who made an error or was responsible
- → Monitoring of the safety management system
- → Maintaining consciousness for safety
- → Modeling of the system and its weaknesses

Main goals of event analysis

- → **Prevention**: Identification of appropriate recommendations after a systematic analysis
- → **Identification of weaknesses** of the system: finding active errors and latent failures (Reason)
- → **Systematic modeling** of the system: Modeling of dependencies and interactions on the base of identified factors, also potential input into probabilistic risk analysis
- → Increase of **systemic thinking**: Conduction and discussion of event analyses show systemic dependencies and tight coupling of technical, individual and organizational factors; Direct way of organizational learning

Event analysis for Organizational Learning

- → Qualitative, not quantitative approach
- → Not necessary to find “true” causes, but find and discuss possibilities to improve the system
- → Focus on all factors which may contribute to an event – including human and organizational factors
- → Analysis method should be applicable for company staff

2 Theoretical background

Definition

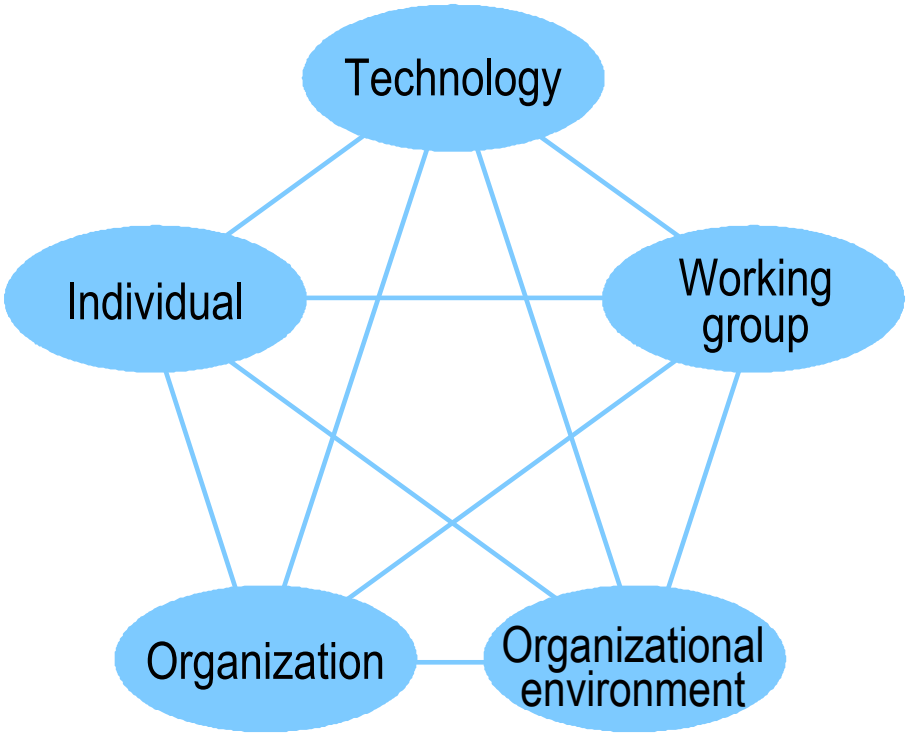
Event analysis is the social accepted reconstruction of the event to be analyzed, i.e. the identification of *what* happened and *why* it happened.

→ For the *what* it is necessary to describe the course of the event as detailed as possible.

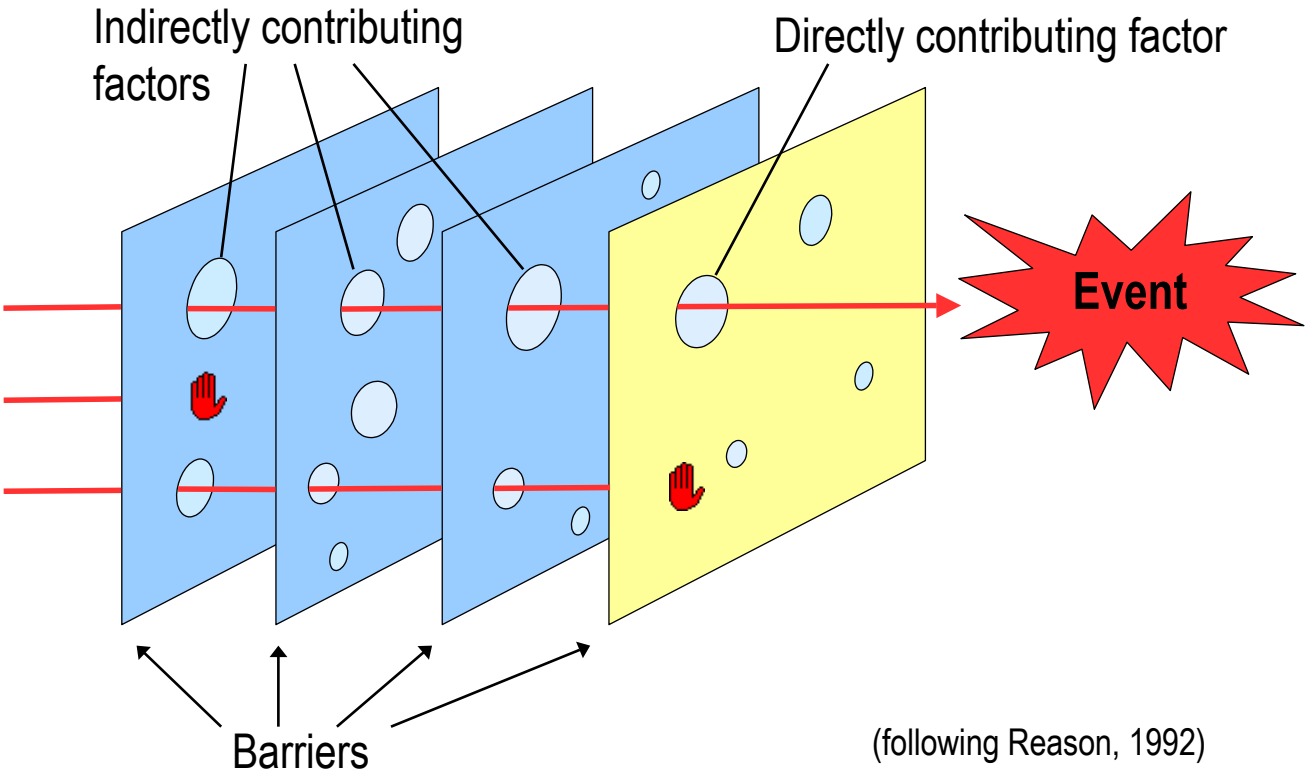
→ For the *why* it is necessary to identify as much contributing factors as possible.

The main problem according to these points is, that it is necessary to go beyond the given information, i.e. to make causal inferences

Systemic view of safety (5 subsystems)



How does an event occur ?



(following Reason, 1992)

Concept of event emergence

→ Events can be described as chain of single events

→ Events occur through interaction of directly and indirectly contributing factors

→ Directly and indirectly contributing factors are located in the five subsystems “Technology”, “Individual”, “Working Group”, “Organization”, and “Organizational Environment”

Causes and contributing factors

→ Hume (1985): Observable, independent events

→ Mill (1973): Stable and constant conditions, productive factors or missing preventive (inhibitory) factors

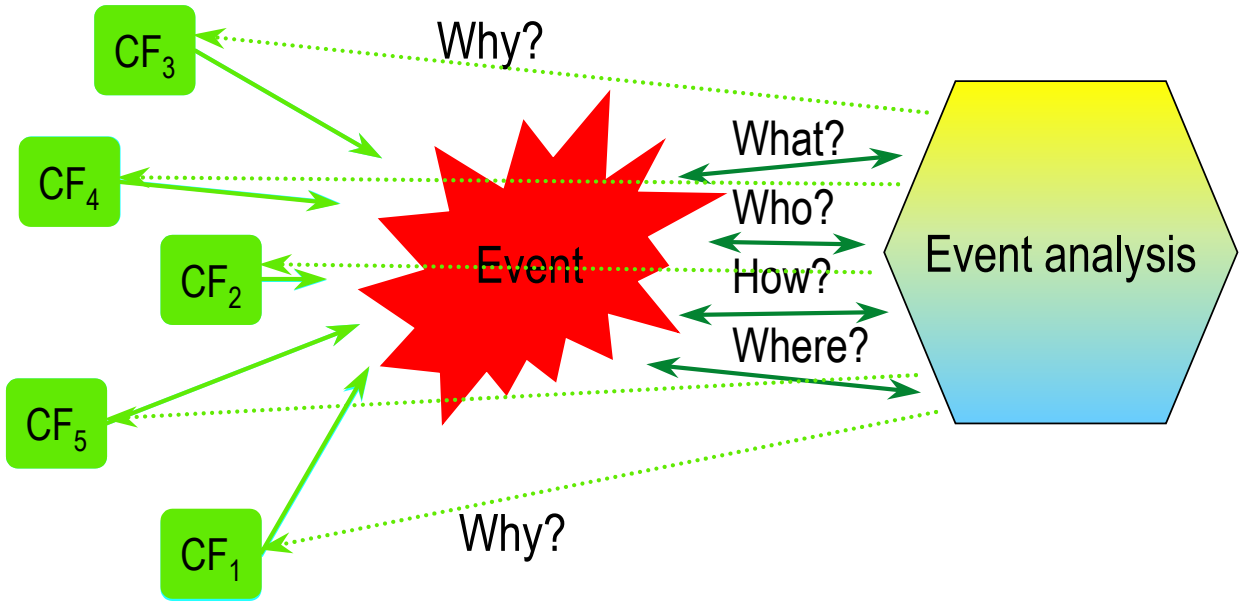
→ Mackie (1965): Stable and constant conditions, productive factors or missing preventive (inhibitory) factors

→ Hart & Honoré (1974): Events as deviation from normal conditions or changes

Notion of **cause** is replaced by notion of **contributing factor**

3 Problems for event analyses

Event analysis from psychological viewpoint



Problems for event analyses I

→ Premature or insufficient generating of hypotheses, which can lead to restricted information and factor search

→ Contributing factors being remote in time and space from the occurrence of the event will not be recognized as such which can lead to an over-weighting of close (time / space) factors

→ Mono-causal thinking / truncated search strategies lead(s) to the identification of only one factor even if more contributed

Problems for event analyses II

→ Omission of factors which contributed by their absence as missing inhibitory factors like barriers

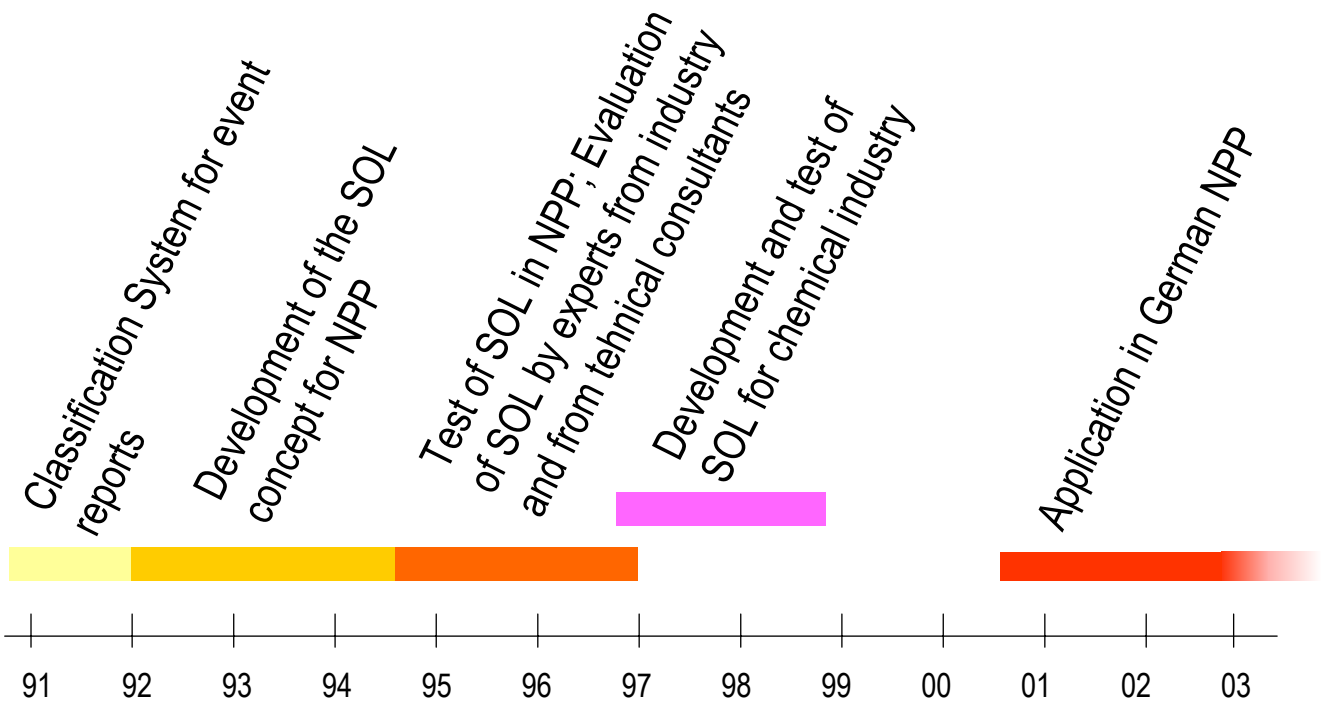
→ Identification of contributing factors because of reference situations (past events)

→ Omission of unreported factors (out of sight - out of mind)

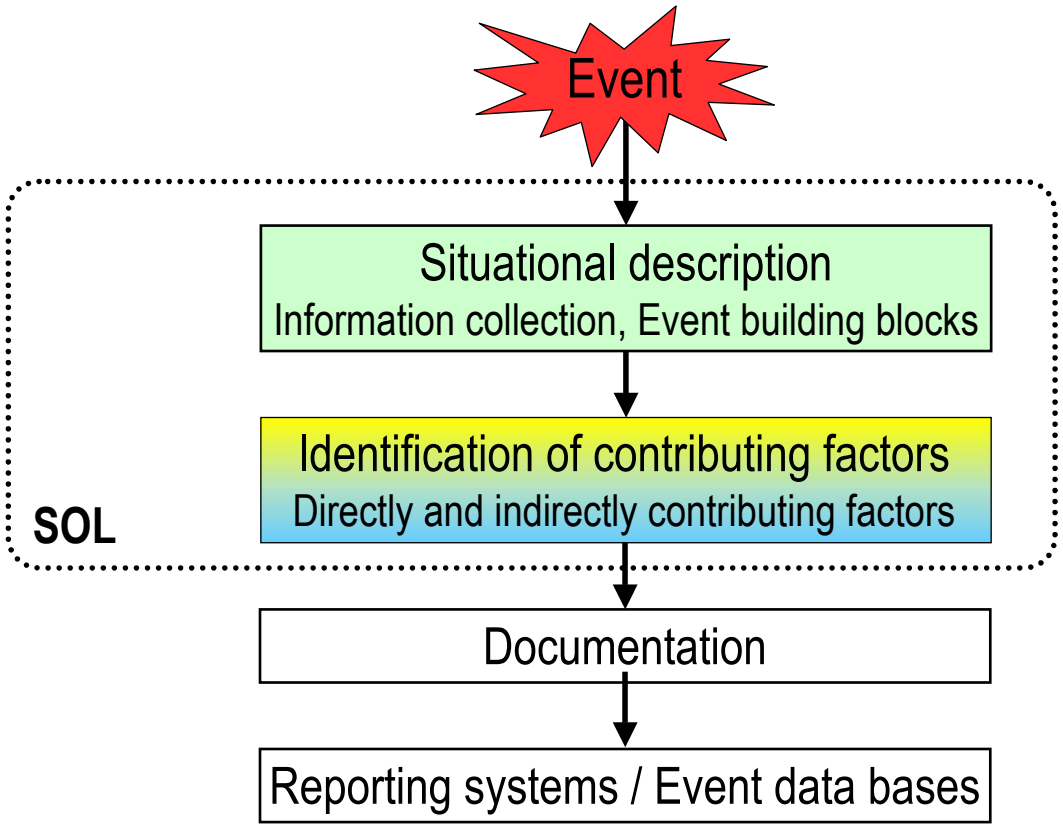
→ Concentration on the individual human performance

4 SOL – Safety through Organizational Learning

History of SOL



SOL: Event analysis procedure



Step 1: Situational Description

Questions and clues for the collection of information

WHEN?	Start/end of the event Start/end of single event building blocks
WHERE?	Location of the event Other locations of actions (control room, ...)
WHO?	Function and qualification of involved persons (shift leader, fitter, ...) Involvement of other departments Involvement of outside-companies
WHAT?	Kind of work/tasks during the event (test, maintenance, ...) Work process, operation scheduling (team work, co-operation, tasks, ...) Operating instructions
HOW?	Separate work or group work Allocation of tasks Used communication tools Disturbancies in the communication Status of involved systems/components/ tools (on/off, test, disturbancy, ...) Automatic/manual operations during the event Working conditions (noise, temperature, wetness, ...)

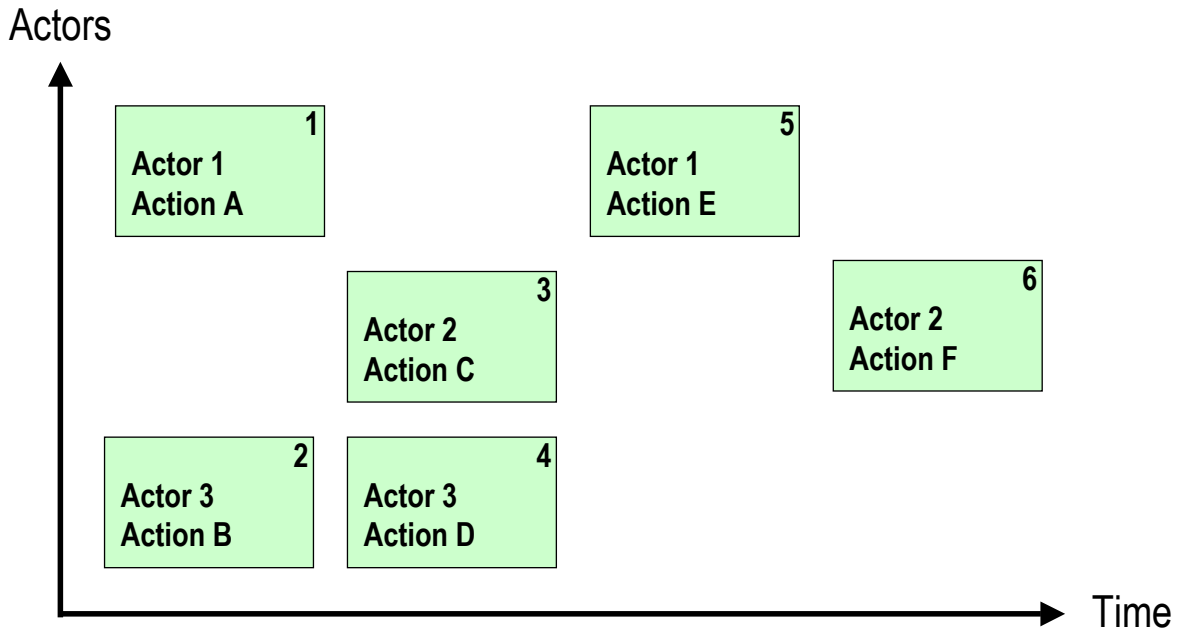
Step 1: Situational Description

Decomposition of the event into “event building blocks”

Nr.:
Time:
Location:
Actor:
Action:
Remarks:

Step 1: Situational Description

SOL Time-Actor diagram



Step 2: Identification of contributing factors

SOL “Identification Aid”

Directly contributing factor	points to	Indirectly contributing factor
E. Violations ***"Have there been conscious violations?"***	1 3 5 6	**8. Control and supervision** ***"Was the operators' performance not controlled or supervised sufficiently?"***
Examples are: • inappropriate transfer of processes from other situations • work performance that violates at least partly prescribed rules • inadmissible reductions during work performance • non-compliance with the safety regulations • evading of control principles ("4-eyes-principle") • ...	8 9 10 11 12 13 18	*Examples are:* • missing "4-eyes-principle" • missing protection against violations of the "4-eyes-principle" • missing control of the work by supervisors or co-workers • inadequate supervision • missing self-control of work results • attaching too much importance to work results in comparison to safe performance • ...

SOL directly contributing factors

A Information

B Communication

C Working conditions

D Personal performance

E Violation

F Technical components

SOL indirectly contributing factors

1. Information
2. Communication
3. Working conditions
4. Personal performance
5. Violation
6. Operation scheduling
7. Responsibility
8. Control and supervision
9. Group influence
10. Rules, procedures and documents
11. Qualification
12. Training
13. Organization and management
14. Feedback of experience
15. Safety principles
16. Quality management
17. Maintenance
18. Regulatory and consulting bodies
19. Environmental influence

Goals for the development of SOL

→ **Prevention against restricted information search:** Separation of situational description and identification, separated search for each event building block

→ **Aid for the identification of remote factors:** Guidance to other factors, examples as aid for generating causal models to build causal chains

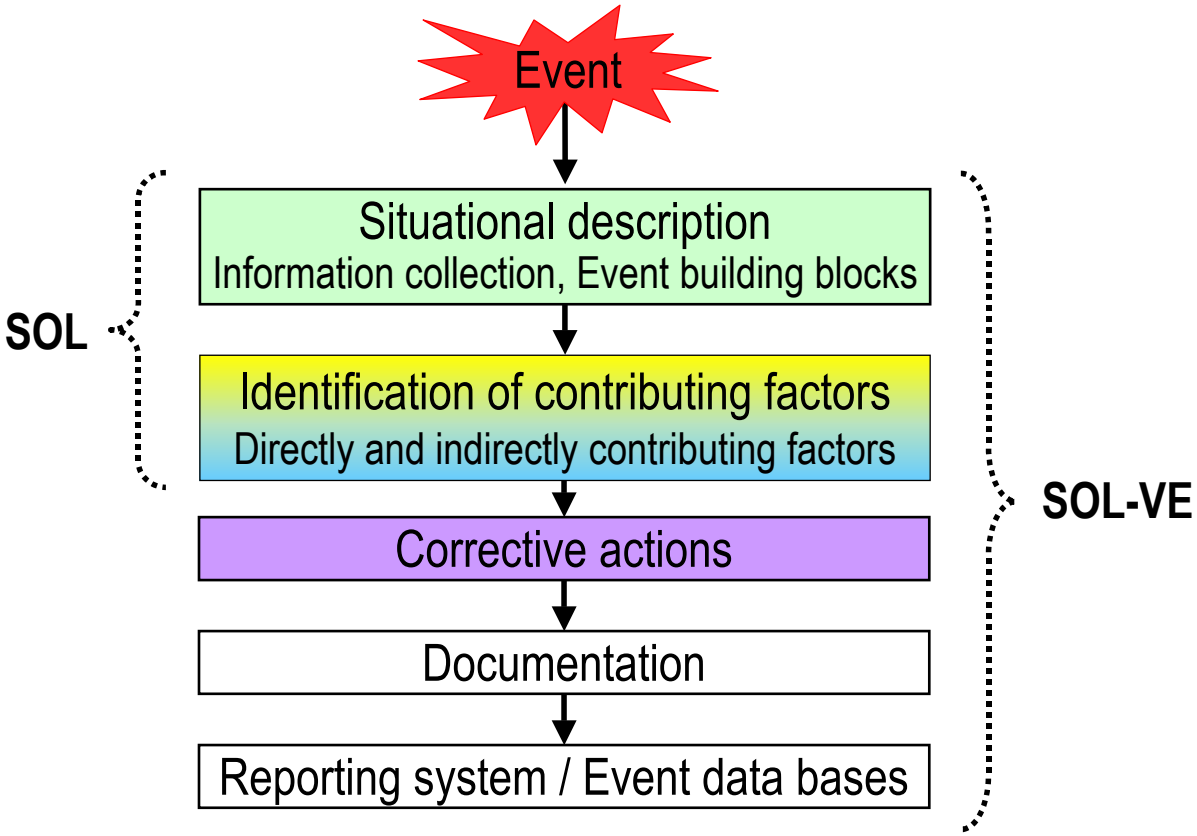
→ **Prevention of mono-causal thinking:** Separated search for each event building block, guidance to other factors

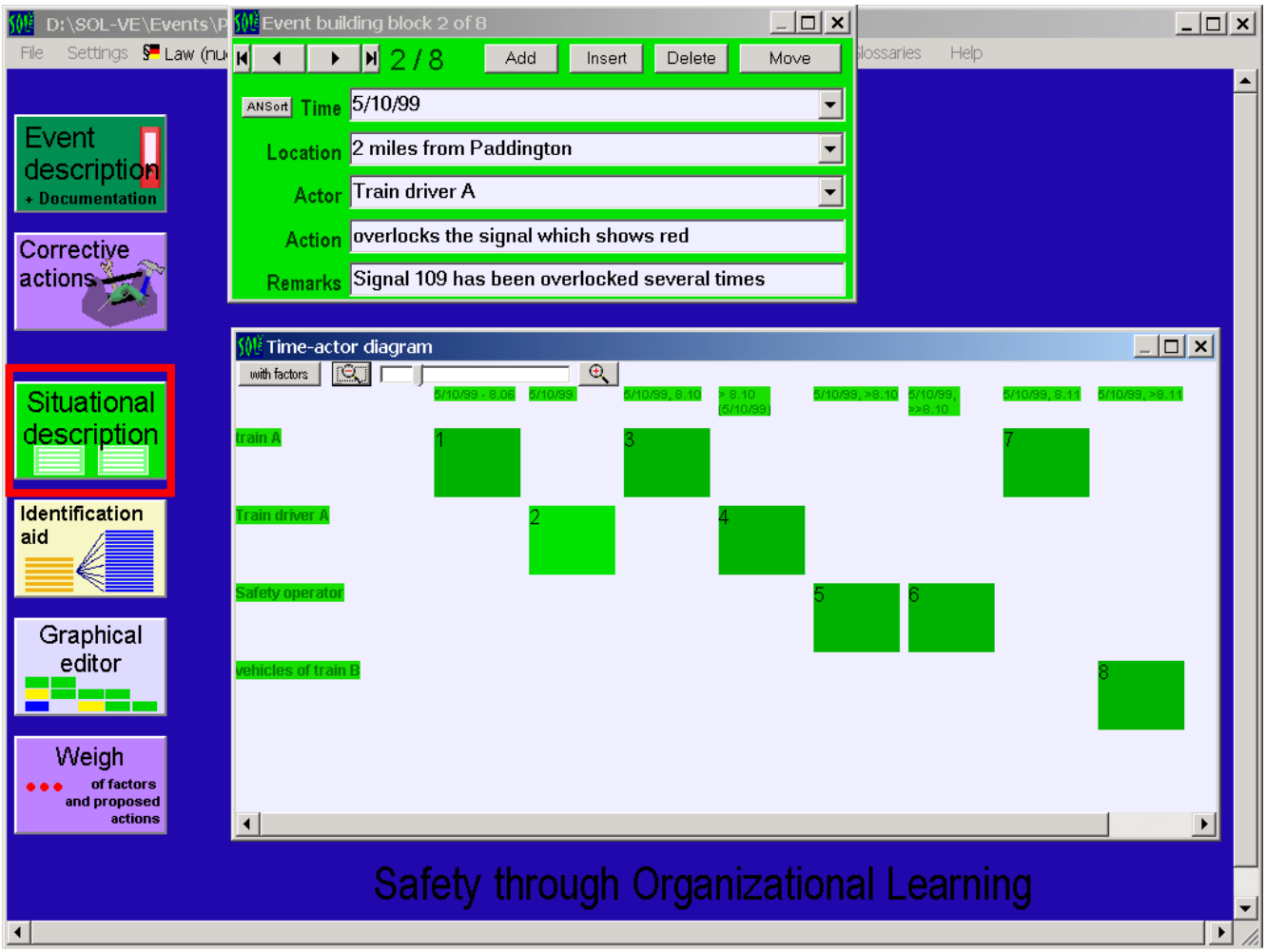
→ **Aid for the identification of missing inhibitory factors:** Formulation of questions and examples

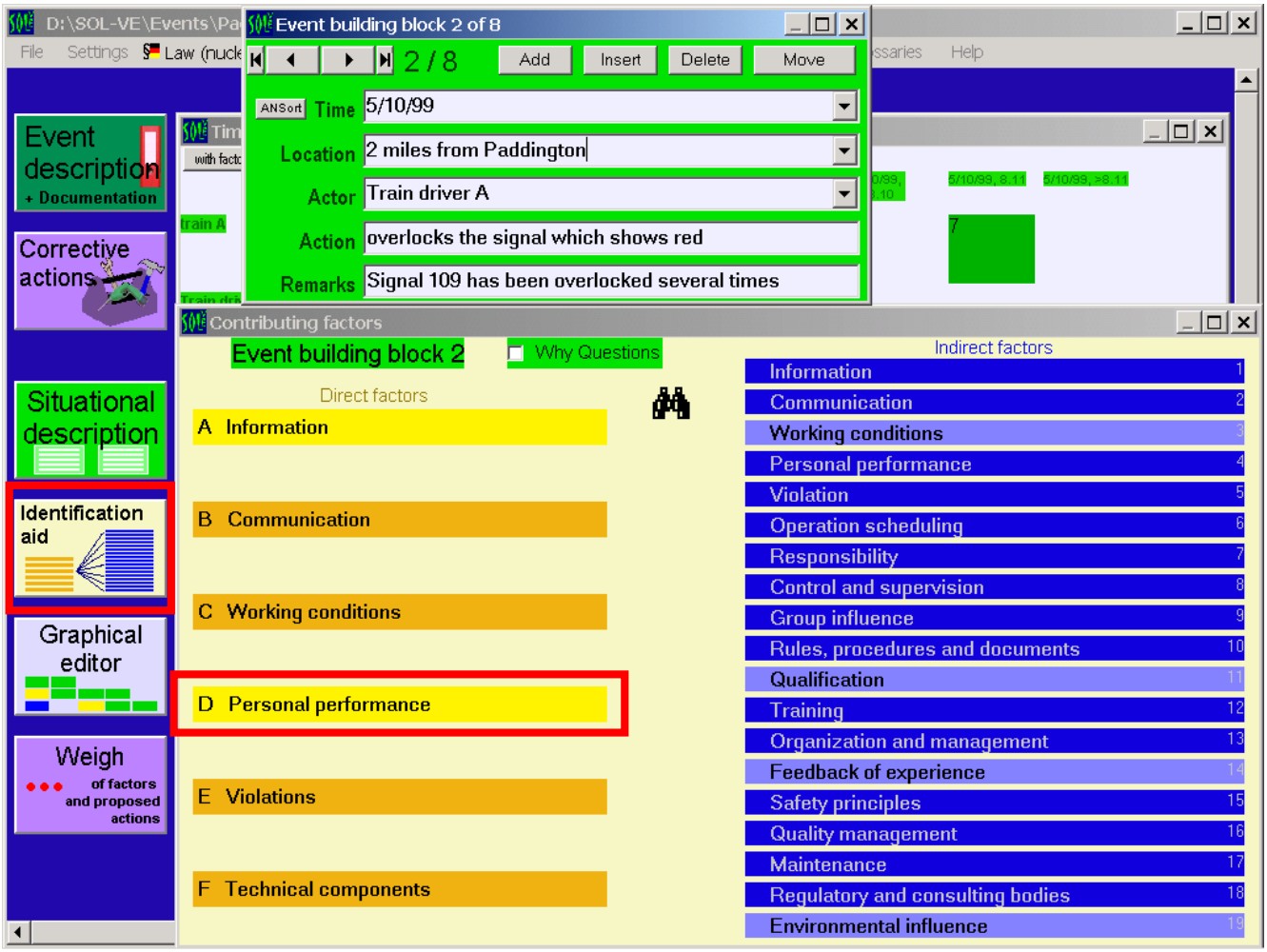
→ **Prevention of concentration on human performance:** Guidance to factors from other subsystems

5 SOL-VE – A software tool for event analysis

SOL - Analysis Procedure




Event building block 2 of 8
2 / 8
Add
Insert
Delete
Move
Time
5/10/99
Location
2 miles from Paddington
Actor
Train driver A
Action
overlocks the signal which shows red
Remarks
Signal 109 has been overlocked several times
Time-actor diagram
with factors
train A
Train driver A
Safety operator
vehicles of train B
Event description
+ Documentation
Corrective actions
Situational description
Identification aid
Graphical editor
Weigh
of factors and proposed actions
Safety through Organizational Learning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Contributing factors
Event building block 2
Why Questions
Direct factors
A Information
B Communication
C Working conditions
D Personal performance
E Violations
F Technical components
Indirect factors
Information 1
Communication 2
Working conditions 3
Personal performance 4
Violation 5
Operation scheduling 6
Responsibility 7
Control and supervision 8
Group influence 9
Rules, procedures and documents 10
Qualification 11
Training 12
Organization and management 13
Feedback of experience 14
Safety principles 15
Quality management 16
Maintenance 17
Regulatory and consulting bodies 18
Environmental influence 19
Event description
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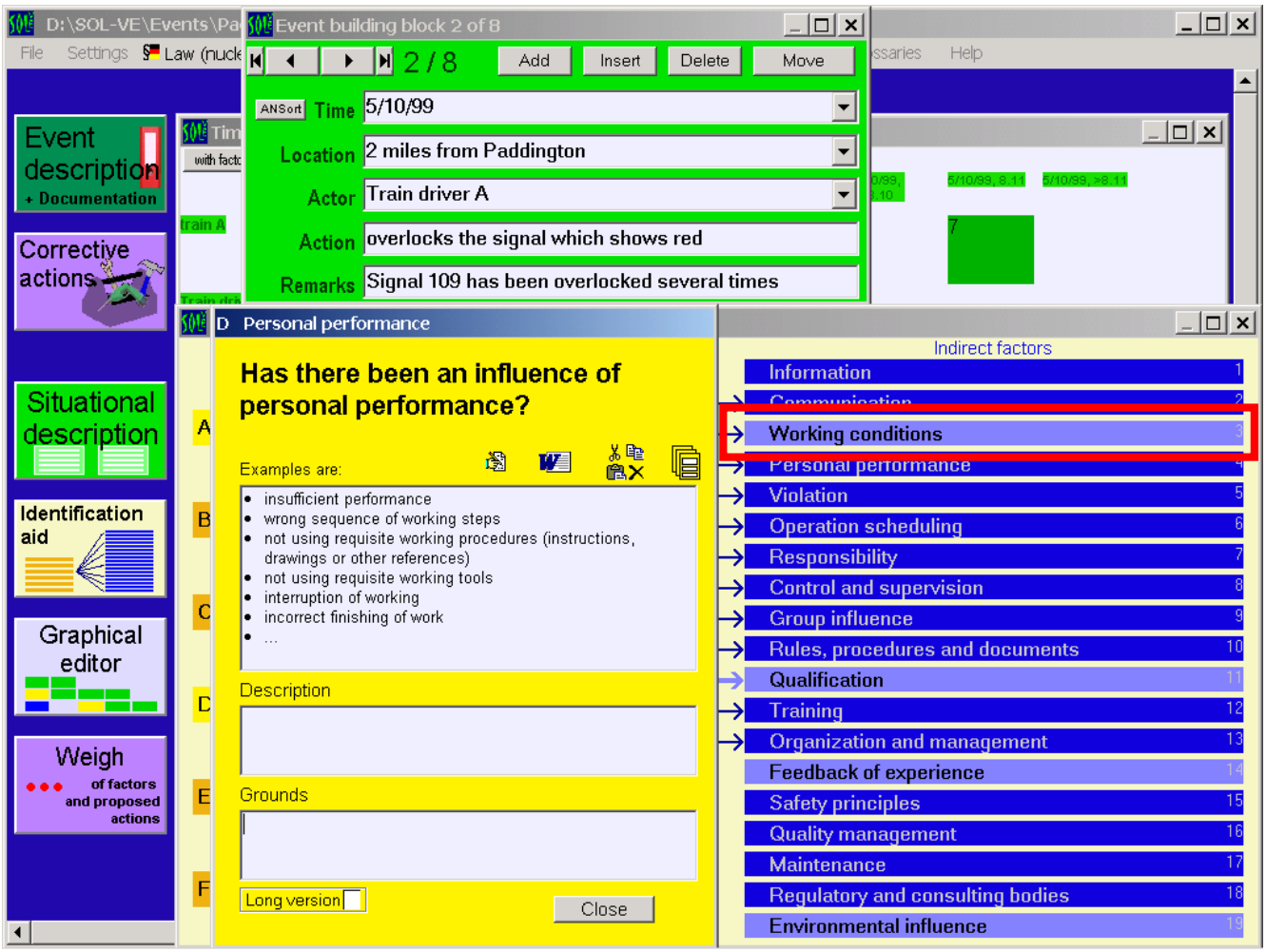
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Event description
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Situational description
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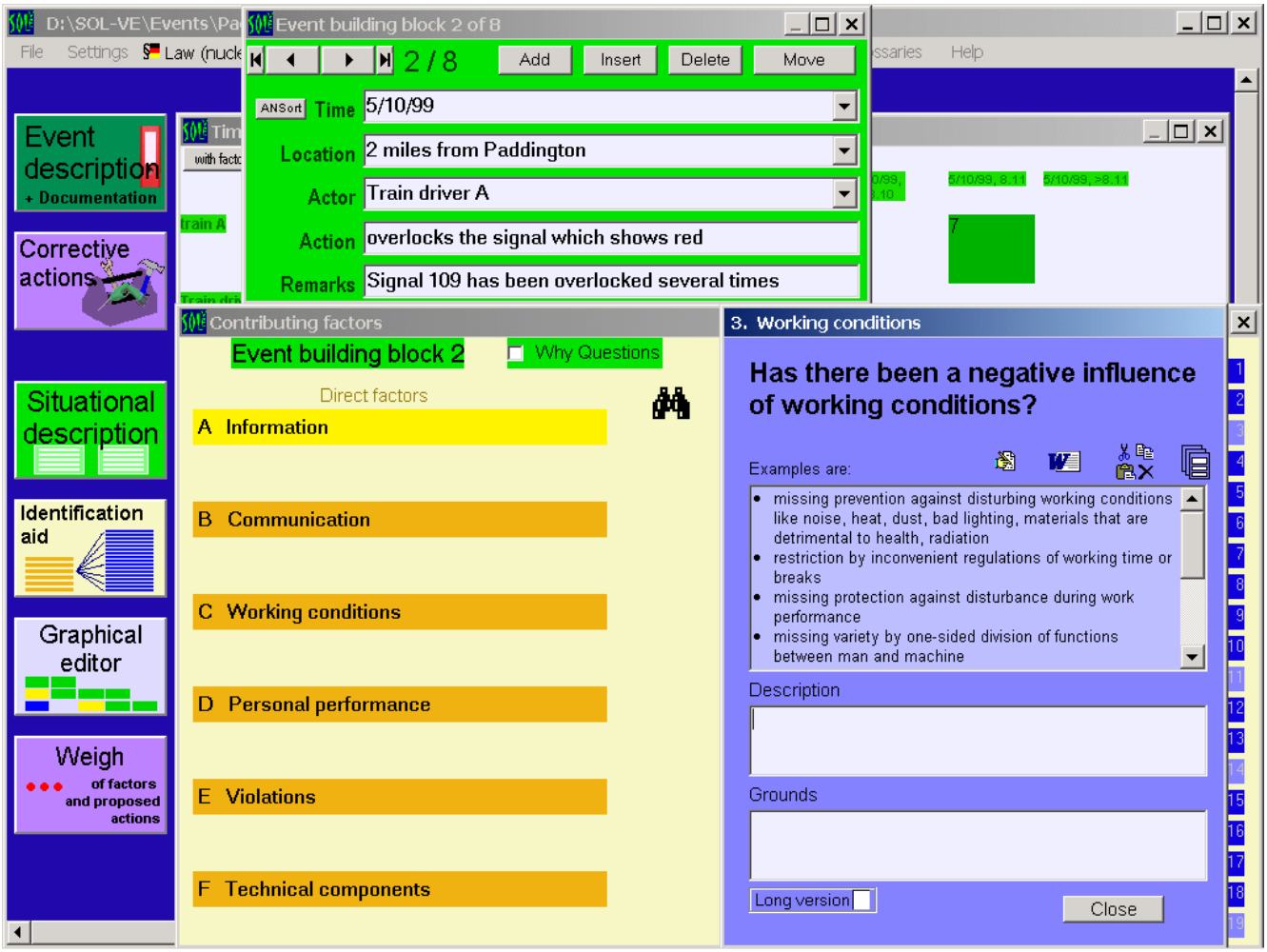
Graphical editor
Weigh
of factors and proposed actions
D Personal performance
Has there been an influence of personal performance?
Examples are:
insufficient performance
wrong sequence of working steps
not using requisite working procedures (instructions, drawings or other references)
not using requisite working tools
interruption of working
incorrect finishing of work
...
Description
Grounds
Long version
Close
Indirect factors
Information
Working conditions
Personal performance
Violation
Operation scheduling
Responsibility
Control and supervision
Group influence
Rules, procedures and documents
Qualification
Training
Organization and management
Feedback of experience
Safety principles
Quality management
Maintenance
Regulatory and consulting bodies
Environmental influence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Event building block 2 of 8
2 / 8
Add
Insert
Delete
Move
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Time
5/10/99
Location
2 miles from Paddington
Actor
Train driver A
Action
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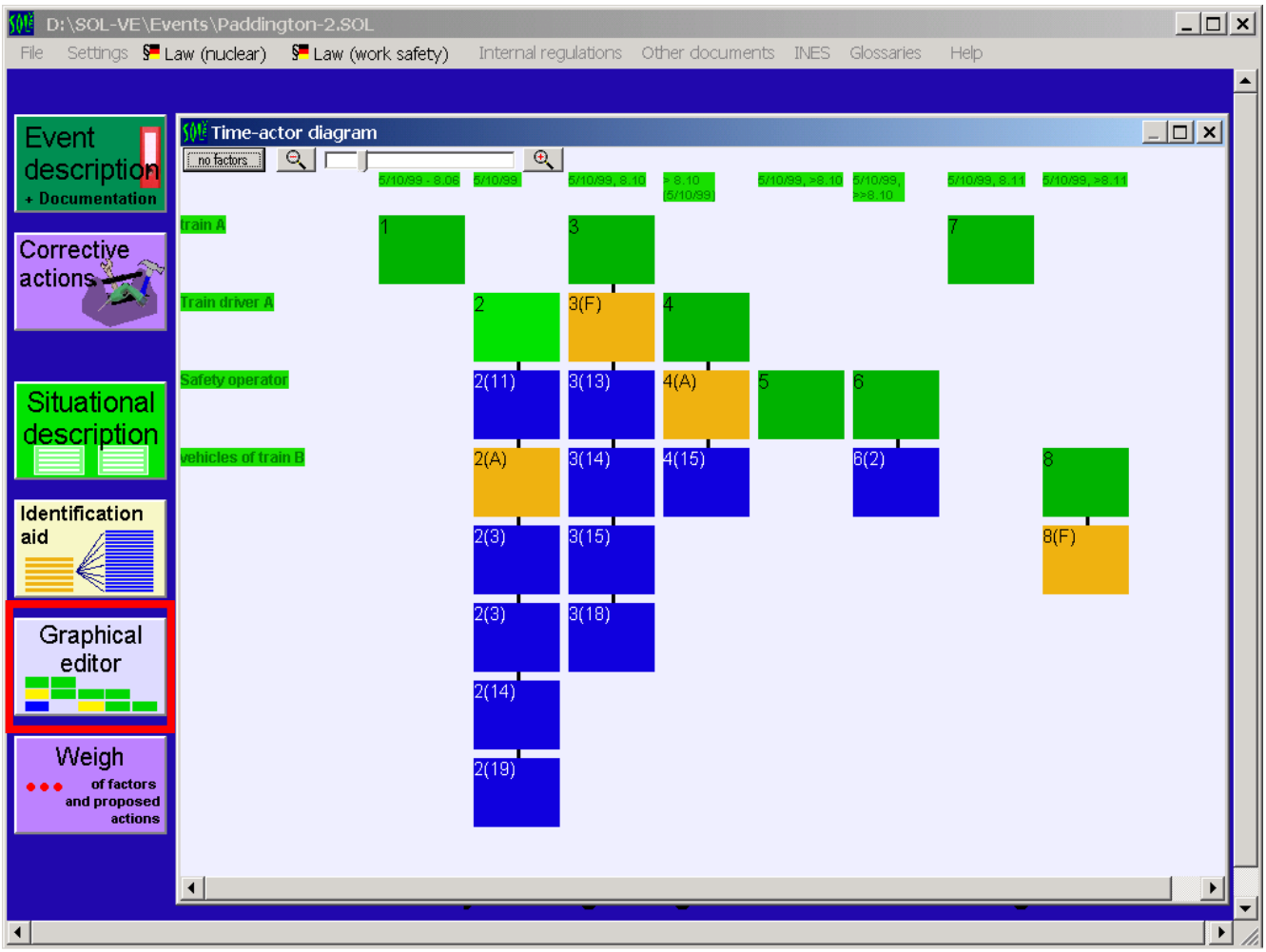
Remarks
Signal 109 has been overlocked several times
Event description
+ Documentation
Corrective actions
Situational description
Identification aid
Graphical editor
Weigh
of factors and proposed actions
Contributing factors
Event building block 2
Why Questions
Direct factors
A Information
B Communication
C Working conditions
D Personal performance
E Violations
F Technical components
3. Working conditions
Has there been a negative influence of working conditions?
Examples are:
missing prevention against disturbing working conditions like noise, heat, dust, bad lighting, materials that are detrimental to health, radiation
restriction by inconvenient regulations of working time or breaks
missing protection against disturbance during work performance
missing variety by one-sided division of functions between man and machine
Description
Grounds
Long version
Close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File
Settings
Law (nuclear)
Law (work safety)
Internal regulations
Other documents
INES
Glossaries
Help
Event description
+ Documentation
Corrective actions
Situational description
Identification aid
Graphical editor
Weigh
of factors and proposed actions
Time-actor diagram
no factors
5/10/99 - 8.06
5/10/99
5/10/99, 8.10
> 8.10 (5/10/99)
5/10/99, >8.10
5/10/99, >>8.10
5/10/99, 8.11
5/10/99, >8.11
train A
Train driver A
Safety operator
vehicles of train B
1
3
7
2
3(F)
4
2(11)
3(13)
4(A)
5
6
2(A)
3(14)
4(15)
6(2)
8
2(3)
3(15)
8(F)
2(3)
3(18)
2(14)
2(19)

6 Evaluation and application of SOL & SOL-VE

Evaluation of event analysis methods

Proposal for criteria for the evaluation of event analysis methods:

→ Prevention of restricted information and factor search because of premature hypotheses

→ Aid for the identification of remote (in time & space) factors

→ Prevention of mono-causal thinking / truncated search strategies

→ Aid for the identification of missing inhibitory factors

→ Prevention of concentration on the human performance

→ Comprehensiveness of the analytical framework, i.e. covering organizational and extra-organizational factors

Results of studies on SOL

→ Difference between individual and group analyses (Lauer, 1997): Groups identify more contributing factors (highly significant difference)

→ Influence of the presentation format (Hille, 1998): SOL does not lead to more “correct” contributing factors, but less “incorrect” ones (highly significant difference)

→ Influence of training (Ritz, 1998): Trained analysts identify highly significant more contributing factors as untrained do

Experimental studies on SOL

→ With SOL more contributing factors are identified than first hypotheses are generated: Prevention of restricted search for factors because of premature hypotheses (highly significant)

→ With SOL it is possible to identify indirectly contributing factors, i.e. remote in time and space: 59,14% of directly and 40,66% of indirectly contributing factors were identified in constructed events.

→ If SOL fulfills the prevention of mono-causal thinking, more than two categories of contributing factors will be identified: 98,3% of subjects identified more than 2 categories of contributing factors

→ With SOL there are identified less factors reflecting human contribution than factors from other domains: Analysis of constructed events resulted in 244 factors judged as attributions to persons and 333 factors judged as non-person attributions (highly significant)

Commercial application of SOL & SOL-VE

→ Since 2000: Application of SOL by MTO for event analysis in several Nuclear Power Plants

→ From 2003: SOL-VE will be the official method for in depth event analysis in all German Nuclear Power Plants