Feedback for Pro-activity

Who should learn What from events, When and How

*Inge Svedung * and Helena Rådbo*

Abstract

This paper is of a theoretical nature. In the introduction the adaptive dynamic behaviour of socio-technical systems is discussed to stress the importance of pro-activity in their control. From there the importance of knowledge, situation awareness and dedicated information governed by local requirements is discussed. Knowledge is seen as a result of learning processes based on experience or information feedback. Such feedback can either be rather prompt or more delayed, indirect and generic regarding content of information.

These processes of learning from events can therefore be categorised with respect to timely and functional directness but also regarding how formal they are. Dynamic decision-making is based on rather direct functionally and timely tight experience feedback with no formal methods associated with it. Event investigation processes on the other hand are more formal and performed either to make detailed in depth analysis of single cases and the developments behind them or to encompass data from several events within a certain arena or type of context. Such processes of collecting, analysing and demonstrating event-experiences are performed to create data adapted to the needs of many actors performing different functions on different hierarchical levels within extensive and comprehensive socio-technical systems. The main purpose of this paper is to set some light on the process of event data collection, handling and utilization in terms of "Who", "What", "When" and "How".

Introduction

Management is about many things and in many respects the understanding of it is based on theories about control of systems that encompass not only the physical level (technical and environmental parts) but also individuals and organisation. All such systems are exposed to external influences ore pressures and manned with individuals with the ability to realise demands for streamlining and to identify possibilities to improve efficiency in a local operational and organisational context. These individuals also have the ability and the motivation to test out such possible improvements and to adapt their future performance based on the experiences gained from such attempts. For good and for bad these adaptive manners are what's behind system's dynamic developments and what constitute management as a dynamic control issue.

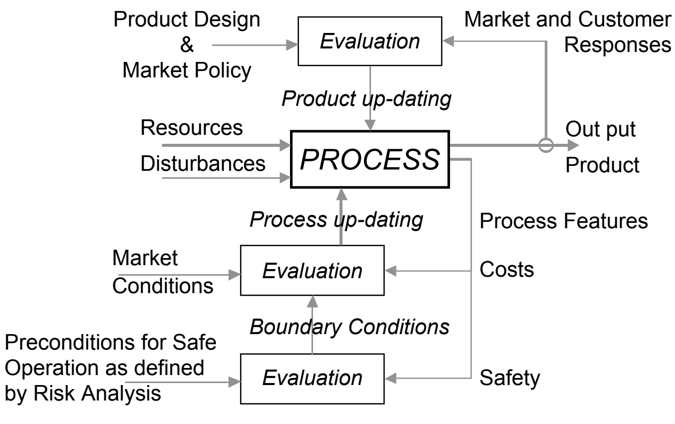

Figure 1. Management can be seen as a control issue with many dimensions. (From Rasmussen and Svedung 2000)

* Inge Svedung (Professor, PhD)
Karlstad University
Dep. of social science
Public health sciences / Risk research
SE 651 88 Karlstad, Sweden
Phone +56 54 700 15 60
E-mail inge.svedung@kau.se
www.kau.se

Accidents and near accidents can be seen as unplanned side effects of normal forward-focused activities that are more or less in line with plans and designs. From a safety management point of view therefore, the knowledge on all hands involved is of vital importance, knowledge of what's critical with reference to systems functionality and safety. From a control point of view, critical knowledge is about systems way of functioning on the one hand and the system state as it is and with reference to the desired state to be in, on the other.

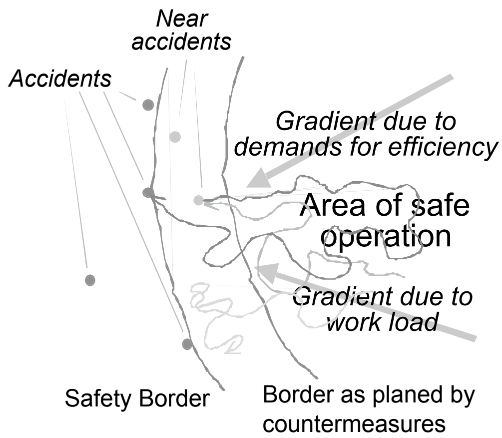

Figure 2. Accidents and near accidents constitutes the experiences that create the counter gradient to unbounded focus on efficiency and workload. Safety can therefore be considered as a dynamical non-event, a state that is supported by visible borders of safe operation. Such borders can be of two kinds. One is constituted by the presumptions that were used as base for design of equipment and routines. The other kind of border is constituted by the experiences drown by actors in the system and communicated to others. (From the "Brownian motion model" by J. Rasmussen)

If these conditions for internal feedback control are satisfactorily fulfilled and the capability, awareness and priorities are right the dynamic decision-making and the corresponding adaptive behaviour can be allowed for and utilised in a secure and profitable way. But this means that also the design process performed to define and create such conditions has to guarantee full knowledge and situation averseness within itself. And it has to do so while encompassing all the functions that the system to be designed will utilise when maintained and in operation. Proper feedback also supports the development and maintenance of people's functional knowledge, awareness and promptness to consider safety. Improper feedback may lead to the opposite.

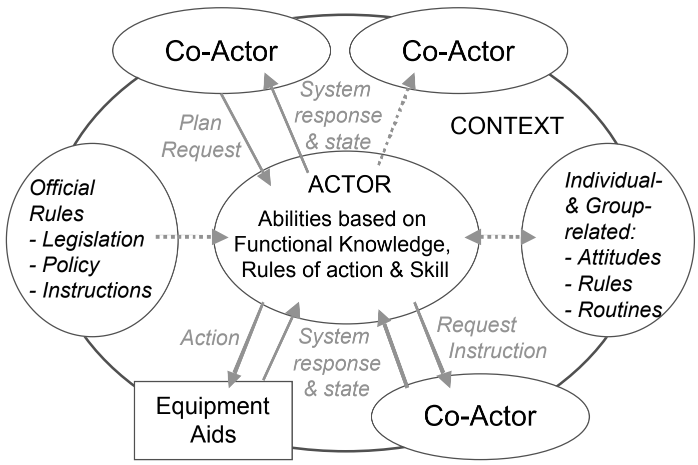

Figure 3. All actors perform their functions in co-operation with others within a local context. They interpret signals from around and react on them based on their own personal cognitive strategies that in turn are based on knowledge, personal rules and skill. When doing so they are influenced by official rules and group-related rules, attitudes and routines.

One function of critical importance for proactive management by closed lope negative feedback is the information management itself. All information, from simple alert signals to intricate statistical data, theoretical explanations, rules and regulations has to be presented when needed and in a form that supports the cognitive processes of the receiving individual and her/his functional understanding of what's at hand. Information that is planned to function as a strong cognitive attractor with respect to a certain issue has to be distinct and associated with a complete set of what's felt by the receiver to be needed to perform this issue.

Knowledge can be seen as a result of learning processes that in turn are seen as fruits of experience, of questions asked and answers received, of try and error or information feedback. These learning processes can be categorised with respect to timely and functional directness and also with respect to the degree of formal organisation by which the processes are performed. Dynamic decision-making is forward oriented in time, based on rather direct functionally and timely tight-coupled experience feedback and with no formal methods associated with it.

Event investigation on the other hand is mainly backward oriented in time and not primarily meant to function dynamically but to supply the actors involved with more basic understanding of the system. The process is more formal and performed either to make detailed in depth analysis of a single case or to encompass data from several events within a certain arena or type of context. The purpose can be two folded. One can be to show the state and trends of maters and to elucidate needs and possible methods for changes. The other purpose can be to utilise the investigation process as a learning experience for the actors involved. Feedback based on official investigations can be categorised as loos with respect to time but also, in a way, with respect to content since data normally are generalised and details are removed when gathered and presented to suit many situations and purposes.

This process of learning from events is about collecting, categorizing, storing, quality securing, analysing and demonstrating event related experiences. It's accomplished by companies, trade associations and on national and international scale to create data that suits the needs of many actors performing different functions on different hierarchical levels within extensive and comprehensive socio-technical systems. The process by which it's accomplished depends on the culture and traditions associated with the context in which the event has taken place and the actual or conceivable outcome of it. It should also be performed in accordance with theoretically framed methods to support analysis and communication of findings.

Events take place in settings where the actor's perspectives are forward oriented. If not the circumstances are felt to be in an alert state they are believed to be under reasonable control with respect to safety and to internal purposes and productivity goals. The context of an event can be demonstrated by clarifying and making explicit the co-operating actors, the functions they perform, the flow and functionality of information, what the technical utilities are, how they function and what their constraints are. Relevant is also the constraints imposed by the environment, the economy, the recourses, the workload, the regulations, the rules and the attitudes.

Below the process of context related event data management is discussed in terms of "Who", "What", "When" and "How" in the perspective of system vide and locally adapted learning for safety.

Who should learn / Actor categories and system level

Events take place in what can be considered as socio-technical systems operated by actors performing different functions on different system levels. These systems are influenced by external forces like; competition, public opinions, technological developments and changing level of education. The way systems perform and develop is also influenced by internal flow of information within and between system levels. The socio-technical system with the vertical flow of information between nested levels is demonstrated in figure 4 (After Rasmussen, 1997[1] and Rasmussen and Svedung, 2000[2]).

In the same framework of interacting system levels the actor categories performing different types of functions can be identified and indicated as illustrated in figure 5. The position of the specific type of actor along the horizontal lines indicates it's operative distance to the physical hazard (after Rosness, Guttormsen, Steiro and Tinnmannsvik, 2002)[3]. It's clear that the functions performed by the actor categories indicated in figure 5 are not only geographically and functionally separated but also timely. But still it's well recognised that by the role they play they influence the way the system functions and develop and thus the varying state of safety.

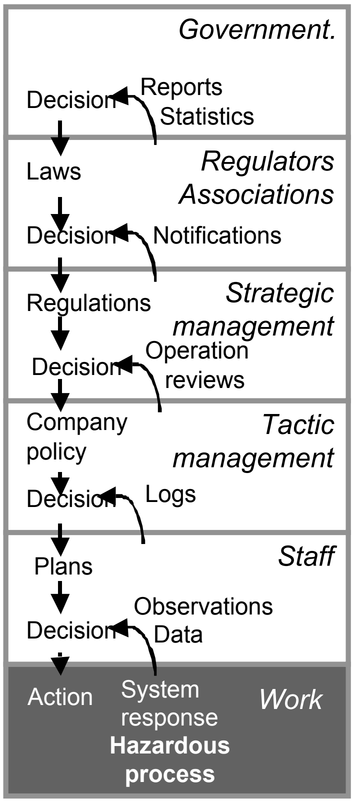

Figure 4. The socio-technical system and the types of information flowing between actors or functions on the different levels. (From Rasmussen and Svedung 2000)

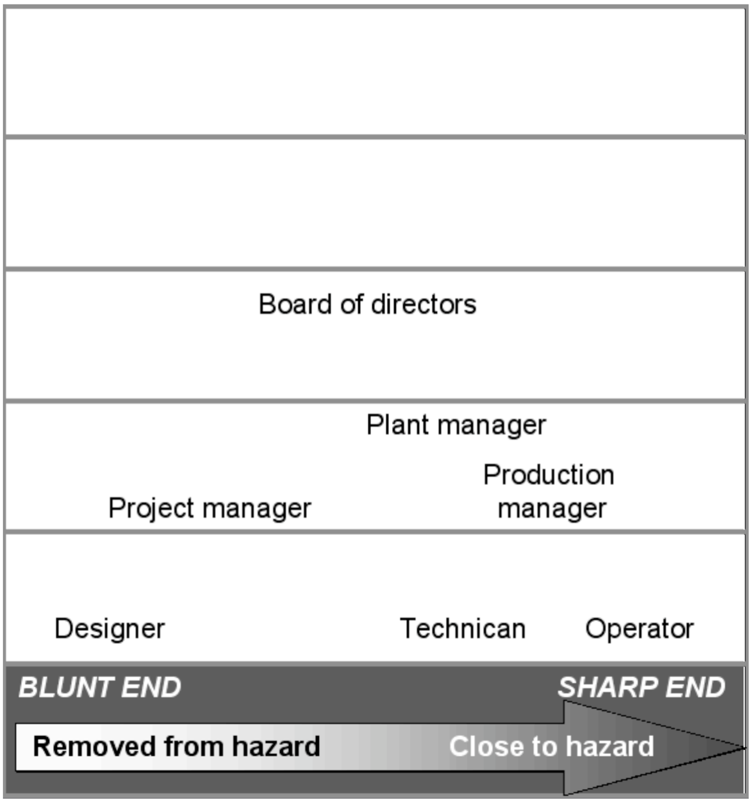

Figure 5. Actors with different functions in the system with reference to how close they work to the hazard and how direct they influence any event that might lead to accidents. (From Rosness, Guttormsen, Steiro and Tinnmannsvik, 2002)

From a broad systems point of view it's realised that there are a great variety of actors that by there normal every day activities can and do influence the systems development. To perform well, situated as they are within rather narrow contexts, these actors should have the proper opportunities to learn from events that occur. Not only about what there own role has been and how they might have influenced the system performance. They also should learn about what others do that can influence the system, why so and how they them selves have to adept their behaviour when considering this. Therefore it's important to involve locally active individuals with different functions performed in the event reporting and analysis process.

When defining what actors that are to be involved it's also important to recognise those, that during normal system performance might be considered to function outside the system, as it's normally defined. This is especially important if not only the preconditions of an accident are under investigation but also the rescue processes that are carried out when the accident is a fact. As an example an attempt to identify and categorise what actors that might be engaged in the situation behind and around a fatal injury due to a train – person collision is indicated in figure 6. The format used, an ActorMap (Svedung and Rasmussen 2002)[4], is in line with the socio-technical model format used in figure 4 and 5.

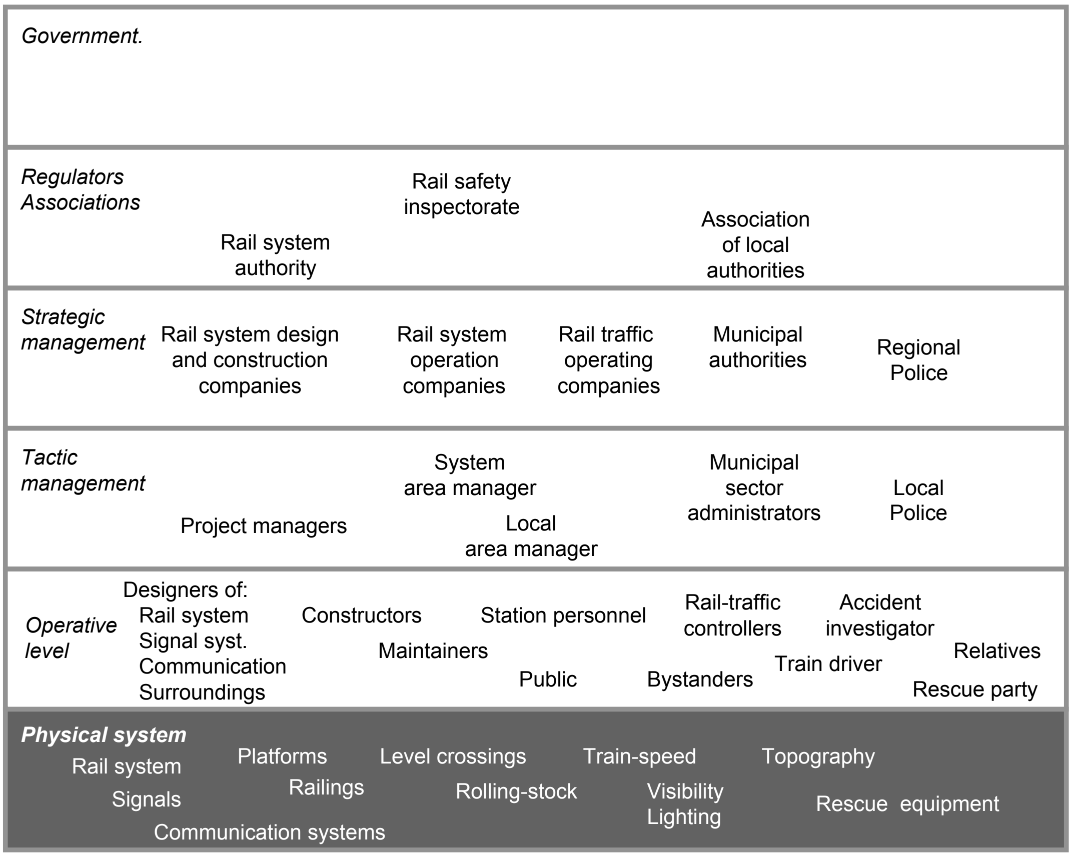

Figure 6 A sketch for an ActorMap with actors distributed on different socio-levels of the system where the preconditions for a train – person collision may develop, where the rescue operation then is performed and where the event is investigated and the findings handled an utilized in future activities.

What should be learned / Level of generalisation

Of general interest to all actors on all levels is to get a picture of their own roles seen in a wither context and if they have got the situation awareness and the priorities right. What signals have they received and how have they interpreted them, what signals have they sent out and have they understood how these signals were received and reacted upon?

What event related data that needs to be looked for and analysed more specifically varies with who she or he is that should learn from that process or rather what function she or he performs. This is not just a simple question about content but also about level of detail or to what degree collected data should be categorised and generalised. The general picture is that details are excluded and data are turned more generic when findings about events are addressed to higher system levels. This trend is described below based on a system structure as indicated in figure 5.

Operative level

An actor operating in direct functional contact with what might have went wrong at the sharp end of the system or an actor ho have a similar role within a similar system, hopefully and most probably have a good understanding of that context. To be of any value to her or him the information gained through event investigations, when presented should refer clearly to that context in a way such that this information can be judged regarding relevance and applicability. If this is not the case the information is likely to be neglected. Information of special importance could be about timely developments, intensity and character such that the data can fit into a causal model of the event as it developed. But also the situation characteristics as they presented them selves to the operator in place are vital, i.e. the mode of operation, the workload, the manning situation, disturbances and other extra ordinary circumstances.

Actors further away towards the blunt end, as indicated in figure 5, might have an interest in information on the same level of detail even if the content of the information requested my differ. A designer's primer interest could i.e. be to learn about how her or his designs are handled and perceived from a users perspective and what basic design assumptions that might need to be made clear in order to work during maintenance and operation as visible borders of safe conditions.

In cases where the system of interest is associated with a physical hazard source with potential to course severe harm and located such that it's tightly coupled with the surroundings then this system in some way is designed for in depth protection of safety. Both technical, operative and organisational issues have been addressed in that design process. This means that the actors involved have many different types of competence that should be used also in an event investigation process. The data to be communicated and analysed in connection with different events are therefore comprehensive. They should be defined and presented to a level of detail that is relevant for the different types of design processes and they should be explicit about what is considered as restrictions critical with respect to safety.

Tactic management level

Actors on the next higher levels in the socio-technical system might still be interested in detailed data about conditions and developments with reference to a certain event. One reason for that is that they have a rather direct responsibility for what happens in their own ore similar part of the system. They also normally have a fair functional understanding of what happens on the level directly under there own so the more detailed data makes sense to them and can be judged and used as base for action.

Actors on this level also need to learn about beliefs, attitudes and priorities among their co-workers, especially those at the operative level below. Therefore it's vital to analyse what's stated on that level as critical preconditions for the events investigated and what circumstances that should be attended to. Vital is also to investigate what type of information that is meant to function as alert signals up and down in the system, how these signals are interpreted and whether they are brought further to others that need to know.

Strategic management level

Actors further up in the socio-technical system often have other backgrounds and ways of understanding or interpreting data presented to them. It also happens that they find little use of the detailed information from a single event since their responsibility is more about long time resource management and policy making. What they need to know is what the trends are, what actors on lower levels are concerned about, how resources are utilized and if there are any special threats that develop and need to be taken care of. So they need data where specific details, that they don't understand or that they don't have the time to go in to, have been remover and where different events are categorised and corresponding findings are assembled and presented in ways that address their needs. To present data in the "scorecard" format have been suggested. This means that the data are presented graphically as outcomes compared with plans or goals.

What actors on high management levels also need to have very clearly presented to them is the vulnerability of what constitutes safety and the need at all times to secure the knowledge, competence and power at lower system levels to manage more directly the hazards they operate. By defining such characteristics in “measurable” terms and stating to what level they should be achieved these data can be compared with findings from auditing and event reporting exercises and presented in the scorecard format.

Regulator level

Actors on the regulator level have two distinctly different but coupled functions to perform. One is about developing and implementing legal rules of conduct and the other is about rule enforcement by inspection. The need to learn about events differs clearly between these two functions.

Rulemaking. To run the rulemaking process actors on that level should learn about the effects and efficiency of different regulatory strategies and they need to understand on what to react, when and for what reasons. Suitable to their needs are mainly what can be described as epidemiological data regarding injuries and damages on arenas that are relevant to their area of responsibility, data that is analysed with reference to relevant attributes or determining factors.

As an example of this kind of data some of the findings from an epidemiological study of fatal accidents related to person–train collision can be used (Rådbo, Andersson and Svedung, 2004)[5]. The following was demonstrated by analysis of events of this type, events that occurred within the Swedish railroad system during the time-period 2000 - 2002. Police investigation protocols are the main source of data. All %-data given are referring to the total number of fatalities.

• Number of fatalities		
o Total	192	
o Suicides	145	75%
o Accidents	15	8%
o Unclear intention	32	17%
• Location		
o Station area	55	29%
o Populated area (not station)	110	57%
• Time of day		
o 00-06	28	15%
o 06-12	43	22%
o 12-18	61	32%
o 18-24	57	30%
• Victim sex		
o Male	136	71%
o Female	52	27%
• Victim age 20-59	134	70%
• Victim’s activity		
o Standing/walking	87	45%
o Lying/sitting	58	30%
o Jumping in front	25	13%

Table 1 Findings from an epidemiological investigation of the accidents related to person–train collisions that occurred within the Swedish railroad system during the time-period 2000 - 2002.

Rule enforcement. Actors performing official inspections are to adjust their strategies and focus to what is stated as explicit demands or restrictions in the directives. Modern rulemaking is mostly about policies to be demonstrated, processes to be performed and plans to be created and documented. Inspection officials therefore don’t get to much practical knowledge about the actual conditions prevailing on the operative level. In the long run this will impair their competence and ability to evaluate what the plans and management processes presented to them are good for. To compensate for this it is vital that inspectors are involved in a selection of event investigation processes in order to judge the role of plans, how they are implemented and evaluated, what their impact are.

When to go for it / Severity, potential to course harm, complexity

In all fields and types of activities there are a great number of events that can and should be used as learning experiences. All events that are recognised as having some potential to course harm should be reported and analysed even if that analysis in more trivial cases are of a standard categorizing nature. The actors directly involved in the events normally perform such handling of event data. Recording and reporting data over time also from events that appears to be trivial can reveal developments revealed to trigger more comprehensive investigations and follow ups.

Events that have lead to more severe damages will catch attention in wider circles. In all cases when people are harmed or killed the event should be reported to the proper authority and an official inquiry should be performed. Such inquiries are normally focused on the blame issue. Still they may reveal some factors of organisational and resource management nature and about attitudes among actors on different system levels. Thorough investigations of that kind can therefore ad important understanding to what safety management is about.

In really severe cases, where the outcomes can be devastating and encompass society as a hole, like in the flight or energy industries different directives regulate the question of investigation, how, when, by home and for what purposes they should be performed. Often a number of commissions are designed to address different aspects of the event, what the direct causes were, how they came about, what the different consequences were and what the more basic preconditions might have been. In such cases also the rescue activities and the handling of traumatised people are investigated.

Since one course behind a system's severe hazard potential is tight coupling to the surroundings and this is normally well recognised such systems are often designed in complex manner with different preventive and confining measures taken. To find out the role of such measures these are often addressed explicitly.

How to learn / Data generating process and participation

The processes of data collection and analysis are coupled by the theories applied. What the selected theories are depends in turn on the questions asked. So there are many methods utilised in event investigations. Some are about the process of on the spot data collection, some about reconstructive data generation and others about ways to go about to collect information through statements and interviews. A schismatic process model of how a more detailed accident investigation can be arranged in two main steps is presented in figure 7.

Also the theories used to support analysis of accidents are of different kinds and framed by different models. There are the more direct process models representing the event chain as it developed. There are causal presentations indicating conditions that prevailed and strictly determined the way the event developed, se the upper part of figure 8. The interpretations of findings based on such models are often supported by other models that i.e. deal with functional coupling, with transfer of energy and mater, with exposure–response relations.

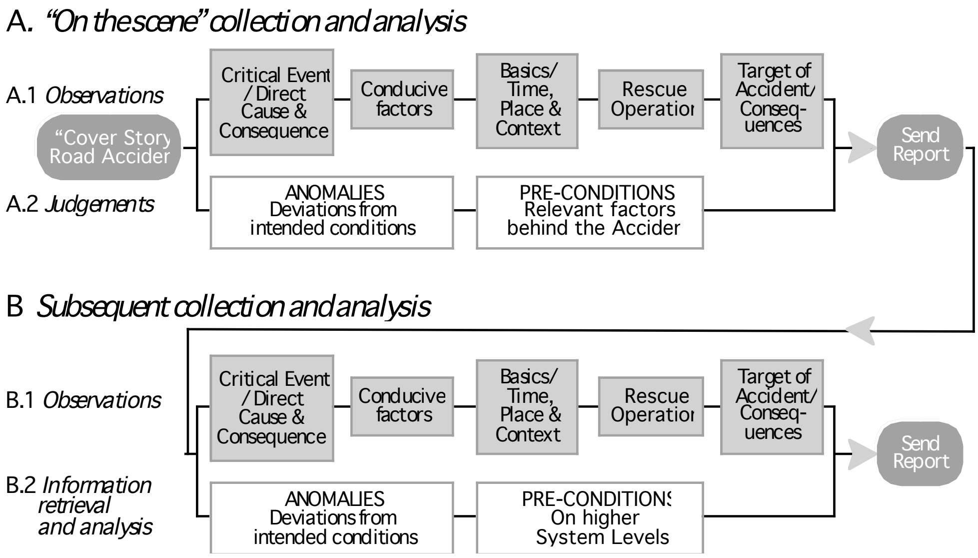

Figure 7. A schismatic model of how a more detailed accident investigation can be arranged in two steps. Indicated is the type of issues that should be addressed to support analysis of the preconditions that shaped the way safety was affected by developments over longer time periods and by actors on different system levels. These actors should have the opportunity to learn from the investigation. The model is originally designed to support analysis of road accidents but it should be applicable also in other contexts. (From Rasmussen and Svedung, 2000)

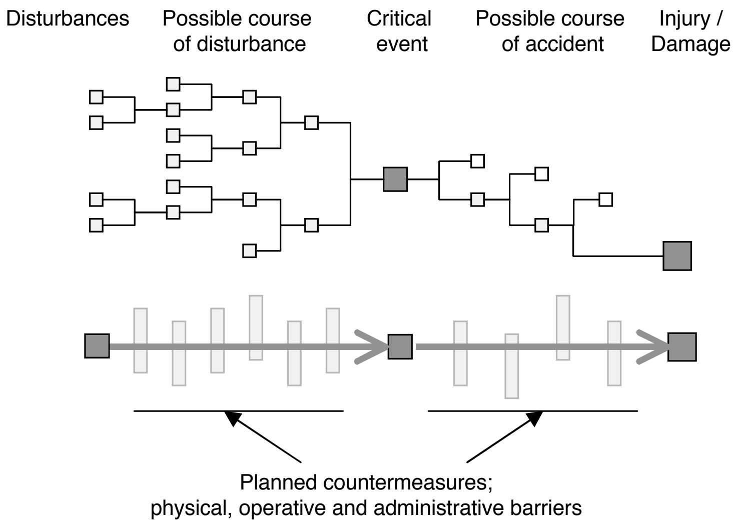

Figure 8. To modelling formats used to describe events as functionally restricted developments. The upper can be recognised as a Course Consequence Diagram and the lower a Dynamic Barrier Diagram, where dynamic refers to the vulnerability of barriers that normally prevails even if they once were designed, tested and believed to function.

From a safety management point of view focus has been on prevention of harmful impact from critical exposures and in that context the barrier concept has been introduced. In cases where preventive barriers have been implemented event analysis normally focus on their reliability and efficiency. The findings presented in table 1 can be looked upon as outcomes of event chains and mechanical impact and the barrier concept, as sketched in the lower part of figure 8, can be introduced to illustrate and analyse the applicability of different types of barriers. From rail bound train system point of view possible barriers could be; fences/railings, early detection of dwellers, train speed adjustment, "soft" engine fronts, rail track selection, light and sound warning signals. To evaluate such possible barriers more detailed investigations of the event conditions are necessary. This means that contexts-pecific data about accidents has to be analysed, data that might call for more event-specific investigations where actors at lower system levels are addressed (See figure 6)

There are also models that frame events as organisational accidents by applying the tree perspectives man, technique, and organisation (MTO). These perspectives can be linked with time by addressing how the preconditions of an event and the event as such develop before, in direct connection with and after that the critical event has occurred. To learn, however, about the role of individuals, groups and organisations with reference to a specific event it's important to bear in mind that these actors function with a forward perspective, even if they learn by reflecting on the past. This means that the analysis should focus primarily on functions performed within the system, how these functions are supported by resource management and information. From there then the outcome of the processes performed should be analysed.

To support the data collection process, the analysis, the communication of findings and the reasoning behind them a format has been developed for presentation and description of data regarding functions performed by the system. This format has been called AcciMap (Svedung and Rasmussen, 2002). It's framed by the socio-technical model in figure 4 and in line with the ActorMap concept as presented in figure 6.

The AcciMap format is presented in figure 9 and an example of what an AcciMap may look like is presented in figure 10.

It should be stressed that these models resembles all other models in that they are not correct, no models are, but that they may be useful.

The usability of the AcciMap format has been well demonstrated by i.e. Hopkins, A., 2000[6], and by Woo, D.M.., and Vicente K.J., 2003[7].

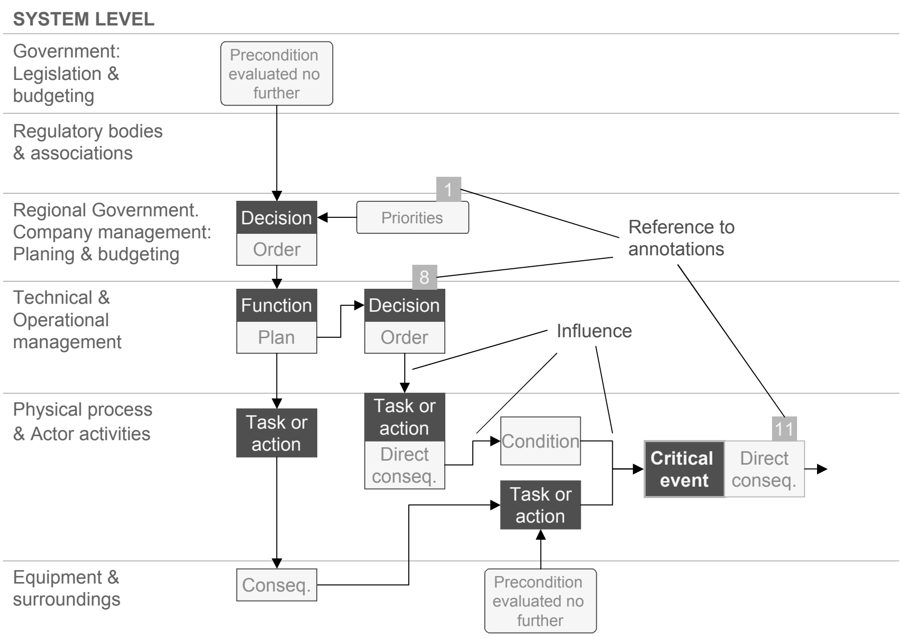

Figure 9. An approach to structure an AcciMap and a proposed legend of standardized symbols.

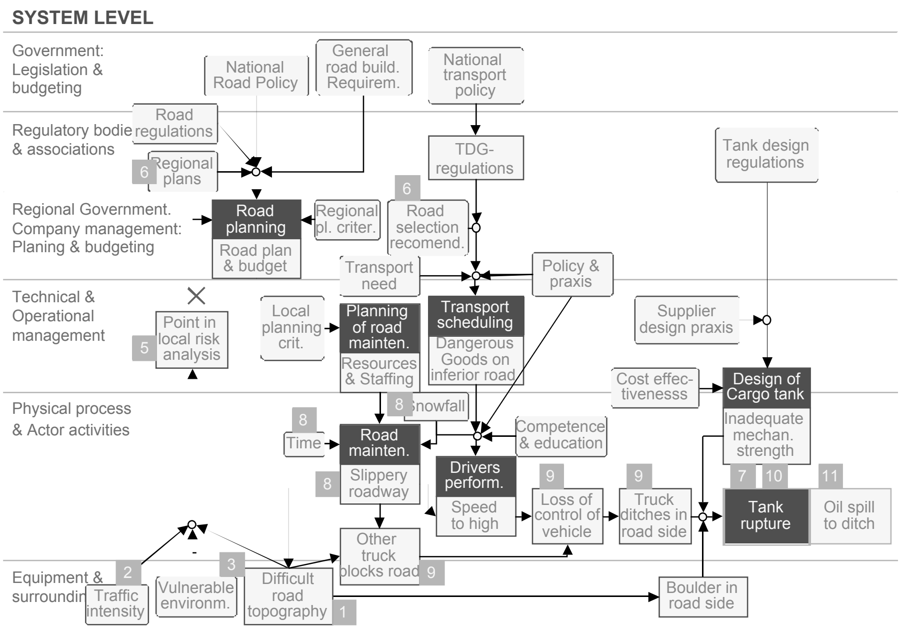

Figure 9. *An AcciMap that demonstrates the pre-conditions of a dangerous gods accident. The physical accident process prior to the critical event is presented at level 5. The second part of the AcciMap, after the critical event, is presented together with the annotations referred to by the numbers indicated in the figure can be found in reference 2 and 4 together with other examples of AcciMaps.*

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