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Root Cause Analysis – the Central Instrument in a Larger Orchestra

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Within BASF there is a large variety of tools connected to learning from accidents or incidents like incident investigation, root cause analysis, databases, short notice communication, detailed communication about severe incidents or accumulation of similar incidents and so for. The critical topic in every incident analysis is to get the real root causes for developing the most wide reaching corrective actions. If the root causes are not addressed but the investigation scrapes only at the surface, than the measures can also not be adequate. This may be the case e.g. if only the personal performance of the injured person is addressed and management systems like a missing hazard assessment are not scrutinized.
Therefore, the BASF method of root cause analysis will be presented. This includes also best practices for a good incident investigation which is the basis for all root cause discussions.
An evaluation – applied to LTIs (lost time injuries) - shows that there is room for improvement with respect to root cause analysis: In some cases the root cause analysis is not done or documented at all and in other cases the focus is only on “personal performance” but other root causes could and should also have been addressed but were missing.
For further improvement of the root cause analysis special training programs have been developed which can be used either by occupational safety as well as by process safety.
Therefore, a good basis is laid for the future incident communication. Immediate causes will be replaced by real root causes and the corresponding measures will develop their full learning potential – keeping in mind that human beings will fail and this cannot be stopped, but minimized by sharing the real learnings of our past failures.

1. Introduction into Incident Management in the BASF Group

Incident Management in the BASF Group comprises accidents, process safety related incidents like fire, explosions and releases as well as environmental incidents. The management of these three types of incident follows the same principles. Therefore, in this article the focus will be only on one of these topics, namely accidents. Within the BASF Group, the following outcomes are distinguished:
Work related accidents:

- dangerous situations
- near misses
- first aid
- medical treatment
- restricted duty injury
- Lost time injury
- fatality

Process safety incidents:

- FERs (Fire, Explosion, Release above certain amount depending on the hazard of the substance)
- AFPDs (Activation of failure protection devices)

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Environmental incidents:

- Releases in air, water, soil

Dependent on the outcome, different actions will be initiated and are described in the next sections.

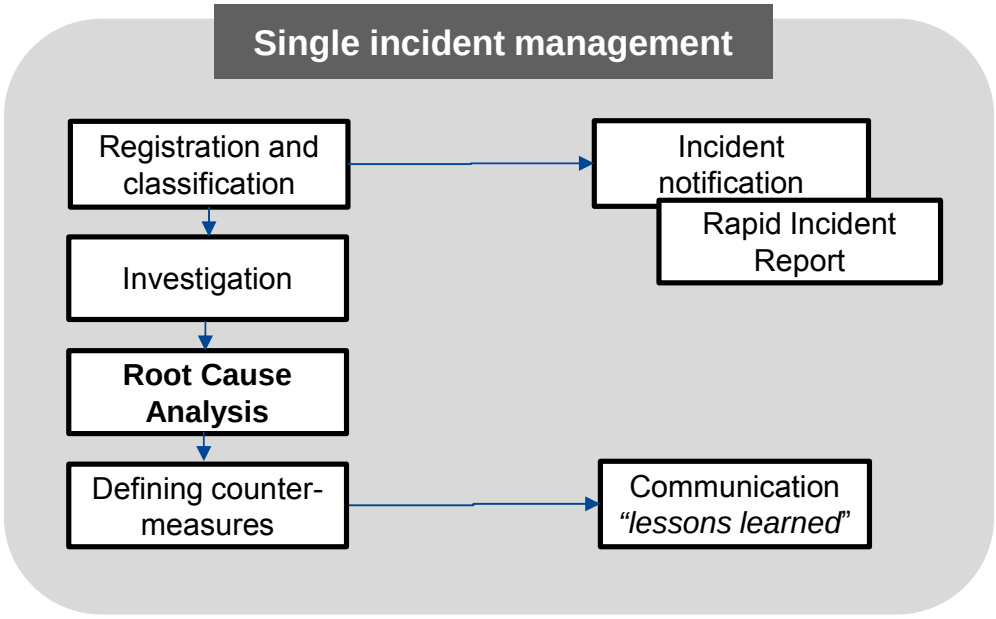

Figure 1: Different components of incident management.

1.1 Rapid information

Every employee has the opportunity to notify an incident he has been aware of in a local incident database. BASF wants to ensure a quick information of the management. Thus, the information is given via a programmed e-mail distributor to the hierarchy of the affected/injured person. Additionally, depending on the severity of the incident also the BASF board and EHS functions are informed within 12 hours.

1.2 Incident investigation

In BASF every incident is required to be investigated to ensure that a reoccurrence is prevented. The depth and method of the investigation is based on the severity potential of the incident. In general, the investigation comprises the steps of

- the collection of facts
- description of the course of events or single steps leading to the incident
- description of the causes
- determination of the corrective actions / preventive measures

Of course the effectiveness of the measures have to be checked after their implementation.

Several investigation methods are used within BASF like incident line, fish bone diagram, incident tree and so for.

1.3 Root Cause Analysis

If a reoccurrence of an incident should be prevented effectively not only the immediate causes have to be addressed and eliminated but also the underlying root causes (see also figure 2). This idea can be tracked back to a concept of Reason (2000). The corrections of failures in the workplace environment, design of plants or in management systems would be much more effective than only addressing the personal behaviour of the single injured or affected person. Thus, root cause analysis (RCA) is a powerful tool for improving safety systematically.

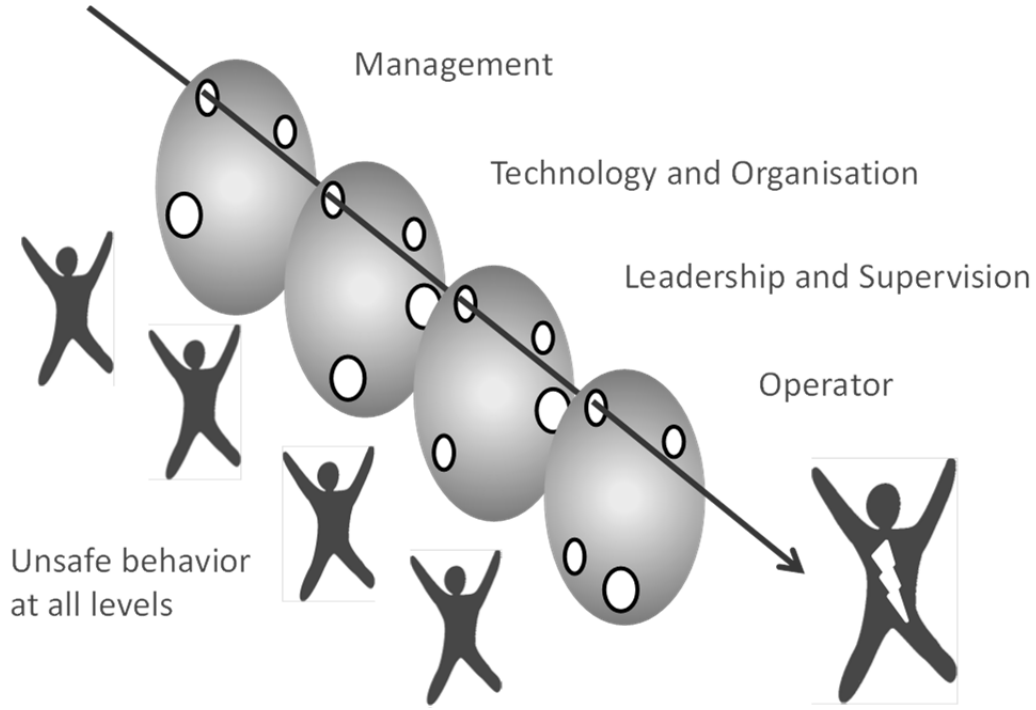

Figure 2: Model for the development of accidents and incidents (similar to Reason (2000)).

In BASF, for the majority of outcomes a subsequent RCA is mandatory:

- Fatalities
- lost time injuries
- restricted duty injuries
- medical treatment

and process safety incidents like

- FERs (Fire, Explosion, Release above a certain amount of hazardous substances been involved depending on hazard potential of the substance)
- AFPDs (Activation of failure protection devices)

Also near misses with high potential are investigated by RCA.

The root cause analysis in BASF follows the Apollo system by ABS Consulting (Vanden Heuvel et al. 2008). There, 12 major root cause categories are addressed which are subdivided in a tree structure to the single root causes (see figure 3)
With this approach BASF wants to assure that also for outcomes with minor current severity but high severity potential root causes are detected as a basis for comprehensive corrective actions and a good learning potential for all relevant BASF units.

1.4 Communication of lessons learned

Since BASF is a company with the large number of about 350 production sites it is very important to share all the findings within this community and not only to improve the situation at that site where the incident has been occurred.
Thus, besides the internal communication of the respective operating division there is a communication concept ensuring that the lessons learned are shared (see figure 4). Depending of the severity potential a one page information is shared in the region or for higher potentials also globally. In the case of more information has to be communicated than only a short one page summary a multipage document with detailed description of the course of events, causes including RCA and complete list of corrective actions is published. This could also be the case, if there are incidents with similar course or causes, thus focus points or trends are evaluated and communicated.

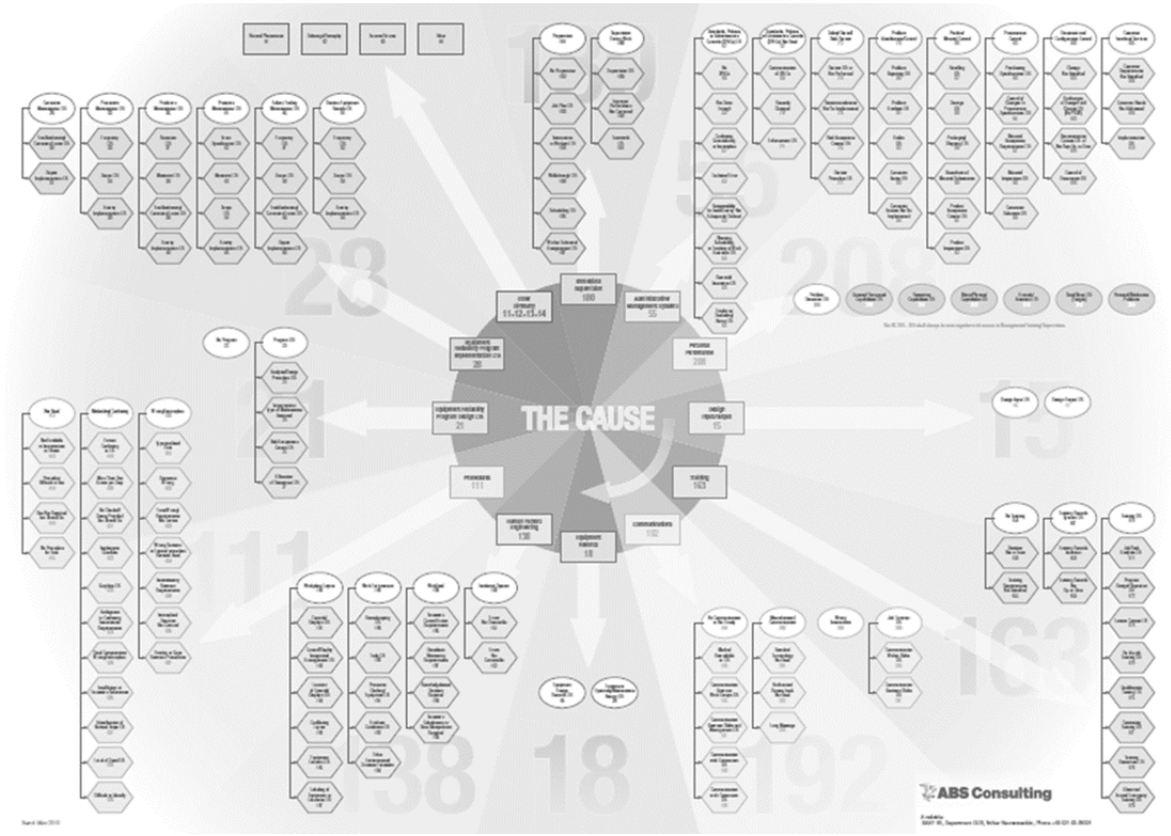

Figure 3: Root Cause map used in BASF Group.

Figure 4: Communication of lessons learned in BASF Group.

2. Gap Analysis with respect to Root Cause Analysis

In the past decades, many organizations put their focus on technical measures in order to improve their equipment, machines, etc. Recently, more and more the individual behaviour is focussed. Thus, also the result of many RCA shows up the personal performance as the only reason for an incident. On the one hand, this often results in the demand of a behaviour based safety program where the behaviour of the individual is addressed and extensive and expensive training programs are offered by many consultant companies. On the other hand, the effectiveness of improvement in safety depends strongly on the choice of the corrective actions. Thus, as described above, the corrective actions can only be comprehensive and systematically be derived if the causes are the real root causes.
Therefore, an analysis of the results of RCA in BASF have been carried out by the corporate occupational safety team with the special focus on the root cause “personal performance”.

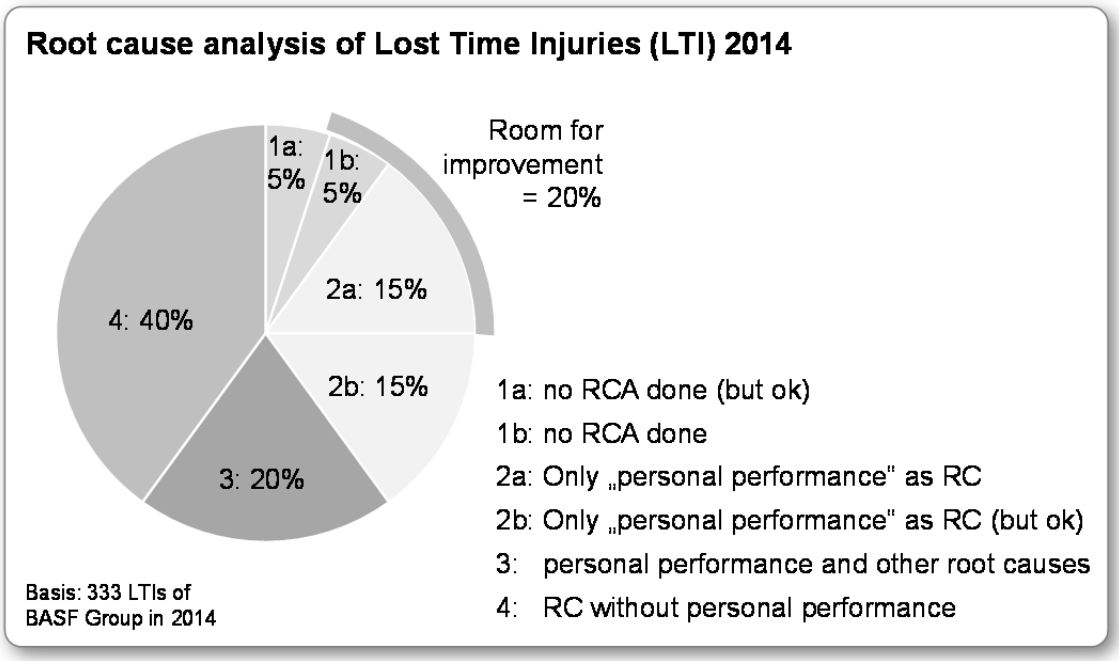

Figure 5: Evaluation of the RCA of lost time injuries in BASF Group 2014.

For this sake the 333 lost time injuries (LTI) of BASF Group in 2014 (corresponds to a LTI rate of 1.5 per million working hours) were evaluated. The result is shown in figure 5. At first, for 10% of the LTIs no RCA was done at all despite it is recommended in principle for this outcome of an incident. A closer look to the single cases shows that in half of the LTIs where no RCA was done a deeper analysis seems not meaningful. This group of incidents comprises e.g. insect bites which lead to allergic reactions, sudden pain during normal movements without any influence from the environment all leading to inability to work. But the other 5% were cases where the reasons are not clear why the RCA was omitted. A short look on the description of the accidents shows that at least one root cause could have been determined.
At second, there was a large group of 30% of the LTIs where only “personal performance” as the sole root cause has been determined. For half of these LTIs personal performance as the sole root cause might be ok, since in this category examples like spraining the ankle by walking on even floor, slipping on something unexpected like pollen dust or hitting the head during straightening up after bending down. For the other half, there is again clear room for improvement. Generally, the behaviour of a single person is embedded in a technical, organizational and social environment. Thus, for these 15% of the LTIs the only root cause documented is “personal performance” even though in these cases insufficient personal performance is embedded in “hidden” or latent causes, which were present mostly a long time before the accident happened: e.g. inconclusive management systems, incomplete hazard assessments, misleading operating procedures, lack of training or lack of supervision - contributing significantly to human error/mistakes.
The third section shows a mixture of root causes where also “personal performance” is mentioned but the other factors are addressed as well. Together with the remaining 40% where “personal performance” does not play a role a good basis for developing comprehensive and wide reaching measures is laid. A spot check

analysis of this majority of incident investigations shows partly room for improvement in terms of consistent use of the method and completeness of the results.

3. Solutions

Taking this analysis as a starting point the corporate occupational safety unit clearly identified three major areas of improvement for RCA: lack of motivation at the manager's level to use the method – lack of knowledge about the method – lack of openness for a self-critical scrutinizing. One could summarize these points with a quotation of Wenninger (1991): „Human Failure as the sole proclaimed unspecific cause of an incident is the excuse of those who either cannot or perhaps do not want to analyze the causes of an incident systematically."

Thus, the following actions were started to cover the above mentioned topics:

1. Motivation for managers
   A short presentation was created describing the sense and goal of the root cause analysis. With a simple example the approach of RCA and its function within the occupational safety management system is explained. Also the basic principles of RCA are taught.
2. Training for plant managers
   A half day face-to-face training course was prepared comprising the above mentioned motivation presentation, a rough overview of incident analysis, a detailed explanation of the method and tools and some hands-on exercises. This concept was tested in a few pilot units for getting feedback on possibilities for improvement. This training concept was taught to regional EHS experts who will transport this method via a train-the-trainer approach to every BASF site in the regions.
   This material is also available at the safety information platform for the purposes of e-training.
3. Integration of RCA as a module in the culture development program
   Since the root causes will only be announced completely either by employees or management when an atmosphere of open dialogue is practiced and a trust culture is established, RCA is placed as one module in the safety culture development program. This ensures a sustainable development of incident and root cause analysis and will drive the change from "looking for someone to blame" to "what can we change to prevent reoccurrence in the future".

Furthermore, this topic was raised to the top management of BASF (board and level 2). Thus, the importance of improving root cause analysis for all level of hierarchies was clear.

4. Conclusions

For a sustainable improvement in preventing reoccurrence of incidents it is important that the corrective actions are comprehensive and systematically deduced. This can only be done when these measures base on the root causes of an incident. From these root causes and the derived comprehensive actions an organization like BASF can learn effectively. Therefore, BASF decided to strengthen the topic root cause analysis and to improve the quality of the incident analysis. Only with a threefold approach instead of a simple training, an effective change will be observed: i.e. motivation of managers, training of shop floor people and managers with respect to the RCA method and an integration of this concept in the culture development.

Acknowledgments

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