#3 – ROLLING STONES
(Environment)

[11]P. Farina, "Si staccano massi dalla montagna, danni a un treno - Radio Lombardia", *Radio Lombardia*, 2022. [Online]. Available: https://www.radiolombardia.it/2021/12/01/si-staccano-massi-dalla-montagna-danni-a-un-treno/. [Accessed: 24- Jul- 2022].

Somewhere in northern Italy, a train line connects the city of Brescia to Edolo, a little town in the Alps. The train track runs across a mountainous area, at times following the profile of the rocks, at times crossing tunnels. On December 1st, 2012, the service was running as smooth as usual, until the train wagons crashed against a boulder on the rails. Not many passengers were on board at that time, and luckily none of them suffered major injuries.

What was a boulder doing on the railways? How did it get there?

Investigations which followed the accident explained how this boulder had detached itself from the side of a mountain adjacent to the railway and upon falling ended up on the train track causing the accident.

What could have been done?

The takeaway here is in realizing the key role the environment plays in the safety of operations and technical systems. The train itself had no defects and operated as regulations entail and performed a routine trip as numerous times before. What is important to realize is that this train track ran along the side of the mountain and in situations like these it is important to consider what the repercussions of this may be. It is not uncommon for pieces of rock to detach themselves from the main body and come plummeting down as happened in this accident. But because we are aware that situations like these can happen, in installing railways and planning train trips along certain environments, the dangers of the environment must be accounted for.

Following the 3 step method presented by ISO 12100, some recommendations apply to cases such as the one described.

Step 1: Inherently safe design measures

Rockslides are becoming increasingly dangerous nowadays due to the increased presence of inhabitants and infrastructure in rural areas, therefore there is a growing need to address such situations properly and maintain safety. There is technology currently available that can be used to detect potential rockslide hazards and gauge slope movement. This technology is called inSAR and LiDAR data and are used to measure displacement of the earth surfaces. These can be used to determine where rockslides are most probable in order to take effective precautions. Via the use of this technology it can be determined whether it is feasible to implement railway lines adjacent to such areas or not. This is a good way to determine if the installation of railway would be inherently a safe option to begin with.

Step 2: Safeguarding and complementary measures

Despite the use of technology presented above, accidents can still occur and secondary preventive measures should always be in place to further decrease the risk. For rockslide prevention/mitigation, there are a few options that can be used. *Wire Meshing* is commonly used for such practices and is placed along and around the mountain to capture any debris falling down. *Retaining walls* can also be used and are placed at the base of the mountain and stops debris that have fallen off and prevents them

from being on roads or other infrastructure. *Soil nailing* is another option whereby steel rods are drilled into the soil of the mountain and increases its cohesion ability making it less susceptible to rockslide. These are all different options which are already implemented and in the case at hand, if present, could have made a significant difference in the outcome of events and drastically reduced the level of danger presented by the environment.

Step 3: Information for use

When the above recommendations are still not sufficient in minimizing the risk to a manageable degree, then communicating risks becomes crucial. Vigilance of railways should be conducted frequently and where there is railway disturbance or potential of danger it should be communicated to train drivers ahead of time in the form of visual signboards placed earlier along the track warning them of the hazard and giving them enough time to reduce speed and act accordingly. Audio signals such as alarms or sirens can also be used to achieve the same purpose. The bottom line is that in these cases, the drivers ideally should be informed of danger so that they are not caught by surprise and are given enough time to take the necessary precautions.

This story is a great representation of the role that the environment plays in engineering and in Safety by Design considerations. We see how it is not sufficient to only address the safety of a technical system, because a system does not work in isolation but rather works in a specific context; therefore safety must also be extended to said context. In that manner, one is able to address all potential factors and risks associated with a technical system.

[9]"Rockslide - Wikipedia", *En.wikipedia.org*, 2022. [Online]. Available: https://en.wikipedia.org/wiki/Rockslide. [Accessed: 24- Jul- 2022].

[10]"Massi sui binari: deraglia un convoglio di Trenord, 7 contusi - TGR Lombardia", *TGR*, 2022. [Online]. Available: https://www.rainews.it/tgr/lombardia/articoli/2021/12/lom-Cedegolo-massi-treno-d99d24e5-10b5-4ebe-97f2-16e53638793f.html. [Accessed: 24- Jul- 2022].

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