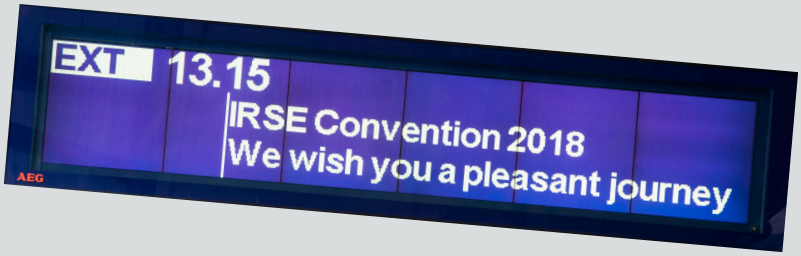
IRSE
Institution of Railway Signal Engineers

IRSE Convention in Switzerland, 28 May – 1 June 2018

Wim Coenraad and George Raymond

IRSE President Markus Montigel and the Swiss Section hosted this year's International Technical Convention in late May and early June. The week was filled with activities for members and guests, as described here by Wim and George, with photos by Paul Darlington.



Monday 28 May: Markus welcomes his guests

About 250 members and their guests assembled at the Hotel de la Paix in Lugano, Switzerland, to hear IRSE President Markus Montigel open his Convention. This year's Convention theme was Safety in Long Railway Tunnels. Over the next four days, we were to visit the 57-km Gotthard Base Tunnel, completed and in operation, the 23-km Ceneri Base Tunnel further south, where trackwork is complete and systems are being installed, and the new 6-km Albula Tunnel to the east, still very much under construction.

After breaking his own guideline on shutting off mobile phones during presentations by accepting a call from Saint Peter (no less) about the weather expected for the week, Markus introduced the programme and Switzerland's Ticino region. He presented to attendees the Convention tie and scarf, arguably the first such items to sport IRSE's new logo.

At the 2017 Dallas Convention, Rod Muttram had cited the Swiss Cheese Model, likening the holes in Swiss cheese to missing safety barriers that must not be allowed to align. The President reminded Rod about this vivid image (warning, the Swiss have long memories!) and presented him with a huge piece of Swiss cheese.

Tuesday 29 May: paper session and the Ceneri Base Tunnel

The first full Convention day opened with a paper session. Hans-Peter Vetsch introduced us to the safety principles for the Gotthard Base Tunnel (GBT). This is based on the automatic inspection of trains before they enter and the minimisation of maintenance-intensive and fault-prone equipment in the tunnel. Emergency stations are located one third and two thirds through the tunnel. An early warning system keeps faulty trains in the tunnel from blocking others. A system ensures spacing so that a train with dangerous cargo cannot prevent a passenger train from reaching the next emergency station or the exit portal.

Receiving the safety briefing at the Ceneri Base Tunnel.

The GBT consists of two 57-km tubes, 178 cross passages and two emergency stations. As in all modern tunnels, the safety concept revolves around enabling passengers to rescue themselves. In the event of an emergency, ventilation systems aim to remove smoke and keep one of the two bores smoke-free. Arrival of emergency helpers within 45 minutes and evacuation of passengers within 90 minutes is the target, with evacuation by trains only. Side tunnels are for ventilation. The control system immediately blocks all approach routes – in both directions – and prevents trains from entering the tunnel. The aim is for all trains to reach the exit portal or, failing that, to get passenger trains to the next emergency station.

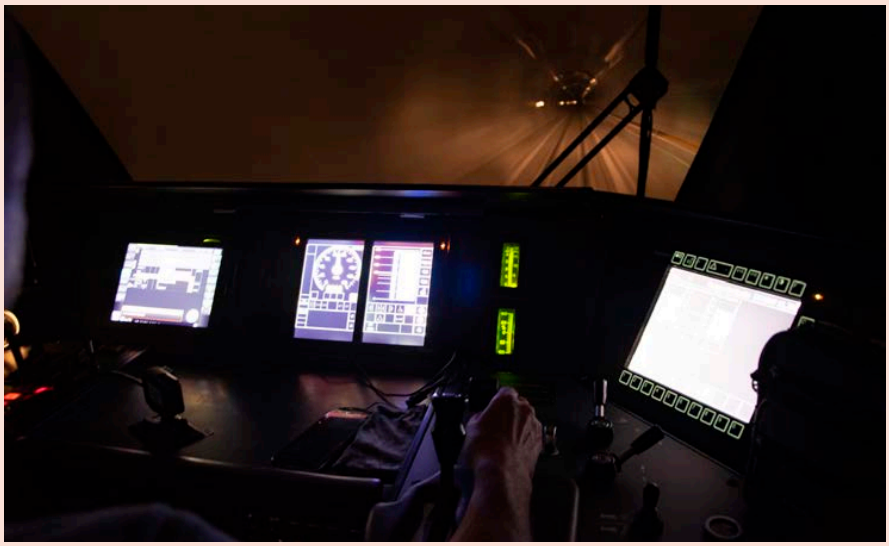
Hans-Peter Vetsch also addressed risk perception and management, pointing out that according to a 1990 study, whereas sharks kill about 10 people worldwide yearly, falling coconuts kill 150. Yet we worry more about swimming in shark-infested waters than about lounging under palm trees. "You have to accept the residual risk, otherwise you will never be finished with a tunnel", he said, but added that "if you don't know the history of previous accidents, you will make the same mistake twice."

GBT signalling and tunnel control

Markus Spindler and Patrick Sonderegger then presented the design principles for the GBT's signalling and tunnel control, which aim to "make it safe and easy to use". This is achieved by a high degree of automation to keep trains separated so as to provide passenger escape routes and monitoring trains which slow unexpectedly.

As would be visible in the cab of our train the following day, the control system monitors the speed of trains as they move through the tunnel. If a train's speed drops below the expected threshold, the tunnel operator makes enquiries and if warranted, raises an alarm. Applying a 'safe haven' principle, the control system keeps a passenger train far enough behind a dangerous-goods train to ensure that dangerous goods never lie between the passenger train and the next emergency station or the exit portal.

The ERTMS specification has the option of reversing a train that has stopped short of an incident out of a tunnel. Switzerland had this function placed in the ERTMS specifications for use in its long tunnels. The reversing requirement also dictated the GBT's signalling architecture, which employs four interlockings, for the north and south halves of each tube. But late in the project, objections arose. Enough track length might not be available to reverse all freight trains out of the tunnel. And an error by the driver when reversing would trigger an ERTMS brake application, blocking the train or seriously delaying its evacuation options. Reversing out of the tunnel was thus ultimately declared unsafe and the option is not used.



A driver's eye view of the Gotthard Base Tunnel.

The safety concept is now as follows: in case of an incident, all trains try to continue and leave the tunnel. If a train cannot continue out of the tunnel, the passenger train behind stops at the next emergency station or, at worst, the next cross passage. From there, the passengers move to the other tube. The ventilation system keeps pressure higher in the healthy tube and smoke out. A rescue train then evacuates the passengers from the tunnel. Drivers of freight trains are expected to leave their train and reach a place of safety, using breathing masks if necessary.

Mobile door

During maintenance work in a tunnel section, a train can drive in ERTMS 'shunting' mode up to 40 km/h. Mobile doors mounted on railway vehicles seal the tunnel section to protect workers from the wind generated by trains passing in the other tube. The next day, in the Erstfeld workshop, we would see such a vehicle and wonder how such a door would be deployed within the confines of a tunnel.

The eight-year GBT signalling project was delivered with an eight-year warranty. This introduced some requirements and issues related to the continuity of teams, the stability of products and standards, and the management of stakeholders and system releases.

Swiss smurfs

Those of us old enough to remember the Interesting Signals column in IRSE News of old were thrilled to observe the special "smurf" signal (blue dwarf signal) at ERTMS stop marker boards in places where the maximum speed is below 160 km/h. This modified shunt signal was in response to driver anxiety about passing shunt signals at danger under ERTMS cab signalling.

Tunnel control system

Peter Müller and Erwin Achermann's talk about the Tunnel control and automation systems (TAG) focussed on the concept of checklist-based and automated emergency responses in the GBT. In long tunnels, designing for safety requires more attention to system availability under the motto "stay available and bring everybody out". This has given rise to new interlocking elements such as directional route locks that keep trains out of the tunnel once an alarm has been raised. The main functions of TAG are prevention, early detection, risk containment, event management and return to regular state.

Wayside train monitoring system

At the Tuesday paper session and in a more detailed presentation on Wednesday in Erstfeld, Stefan Koller described the wayside train monitoring system (ZKE) of Swiss Federal Railways (SBB). Part of Switzerland's safety strategy is ensuring that only healthy trains enter the long Swiss tunnels. This is one reason why 200 wayside train defect monitoring systems are found across the Swiss network, monitored by operators in centres at Erstfeld and Luzern. For ongoing tracking of a wagon's condition, SBB is encouraging wagon owners to

install RFID tags on their wagons. In return, the wagon owner gets free access to SBB's data on the wagon.

In other talks at Tuesday's paper session, Gilbert Zimmermann presented the state of the RhB's Albula Tunnel after 114 years of service, the project to build a new, parallel tunnel, and the geological challenges its builders are facing. Pierre-Damien Jourdain updated us on ERTMS deployment worldwide and Oskar Stalder introduced us to the Gotthard mountain route, which opened in 1882 and is now a scenic alternative to the GBT. The scene was thus set for the week's site visits.

Ceneri Base Tunnel

On Tuesday afternoon,we visited the north portal of the 23-km Ceneri Base Tunnel (CBT), planned to open in 2020. Built south of the GBT on the same line by many of the same teams, the CBT will further shorten transit time and eliminate the last steep grades of the Gotthard route, allowing a single locomotive to pull most freight trains unaided. At the CBT's north portal in Camorino, half the group visited the two tunnel tubes and one of the connecting cross-passages, and the other half inspected a technical building and a sample track section. Placement of a Golden Sleeper the day after our visit marked completion of track installation in the tunnel. Just inside the tunnel's north portal are two 160 km/h turnouts connecting the CBT to both Locarno to the west and Bellinzona and the GBT to the north. The turnouts are equipped with swing-nose frogs and multiple hydraulic point machines.

Inside the Ceneri Base Tunnel.

Members reflect on their 1-km walk through two tubes of the Ceneri Base Tunnel.

Wednesday 30 May: old and new Gotthard tunnels

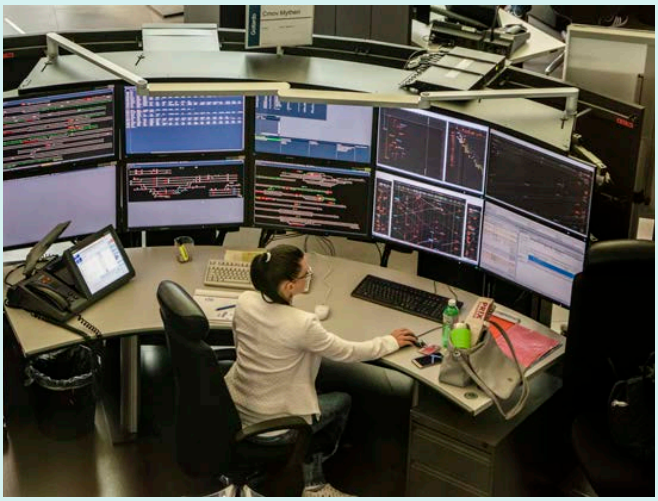
An early bird would have seen us walking through the streets of Lugano to Paradiso station, where a special train took us to Biasca, at the GBT's southern portal. There we toured the Gotthard line control room that houses the tunnel's operators and traffic controllers. Virtual reality headsets let us glimpse SBB's trial applications of virtual and augmented reality in training and maintenance.

Expo Biasca

At an exhibition in Biasca created just for the Convention, stands presented railway technology and operations in the GBT and Switzerland. At one stand, Lego trains illustrated the tunnel's operational and evacuation concepts. Hans Peter Vetsch expanded on his earlier explanation of tunnel safety and evacuation concepts and escorted us through an evacuation drill.

Departing Lugano-Paradiso station aided by one of our excellent guides.

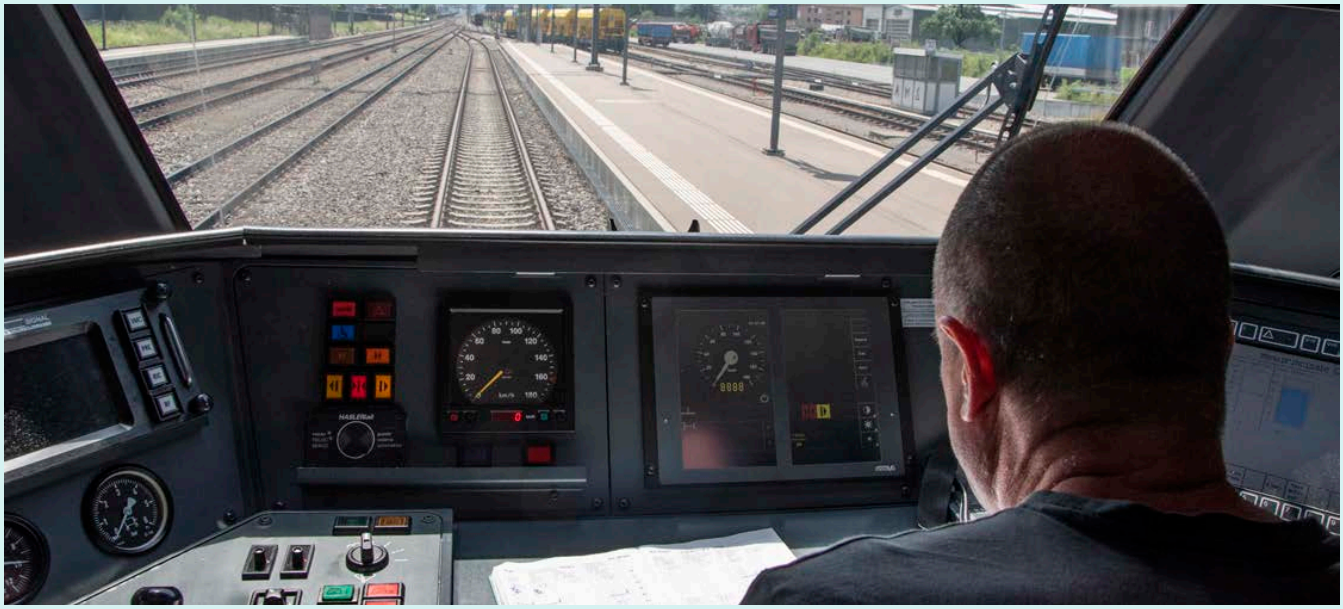
Arriving at the impressive Gotthard control room.



A controller in the Gotthard control room monitors traffic.

A heritage locomotive outside the Biasca exhibition.

Refreshments at Biasca.



Members inspect the cab of the special train through the GBT to Erstfeld.

Erstfeld

We then re-boarded our special train to ride north through the GBT to Erstfeld. At the request of members in his cab, our driver slowed for a closer look at one of the intermediate emergency stations. This let us verify first hand that the control centre does indeed monitor train speed as upon detecting the unplanned speed reduction, a control-centre operator contacted the driver.

After a musical lunch in the Erstfeld workshop, where we enjoyed our President's regional menu, we saw a snow plough and the puzzling mobile GBT tunnel door on its support vehicle. A more in-depth presentation and demonstration of the ZKE system followed lunch.

We then rode a special train with panoramic windows south over the Gotthard mountain route. IRSE legend Oskar Stalder narrated the splendid scenery and spectacular contortions of the Gotthard mountain route, which among other feats passes Wassen church three times, the church where Oskar was baptised and married. The route's summit is the 15-km, original Gotthard tunnel of 1882. The Gotthard mountain route remains a wonderful alternative to the faster but (normally) monotonous 57-km ride through the GBT.

Enjoying the spectacular views from the panoramic car as we travelled over the older Gotthard mountain route.

Thursday 31 May: from Lugano to Pontresina

Members and guests travelled from Lugano to Pontresina (Switzerland) for the Convention's final two nights. A spectacular coach journey, mostly in Italy, brought us to a delightful lunch in the restaurant La Brace in Forcola and on to our Swiss Bernina Express train in Tirano (Italy).

Between Lake Como and Tirano, our coaches' route often paralleled the Italian State Railways' line, along which we observed the searchlight-type signals common in Italy. Such signals can display any of several colours (such as red, yellow and green) through a single lens. Originally, a mechanism inside the signal head swung a filter into the light beam to show the required colour. Nowadays, such mechanisms are giving way to LEDs that display the right colour without moving parts. Members said that Australian searchlight signals are undergoing the same transformation.

The Italian town of Tirano, 429 metres above sea level, is the southern terminus of the Bernina line of Switzerland's Rhaetian Railway (RhB). Our metre-gauge train made a dramatic ascent through countless curves to Bernina Pass, passing the Morteratsch glacier and the highest peaks of the Swiss canton of Graubünden. With 55 tunnels and 196 bridges, the route is the highest railway across the Alps but makes no use of racks despite grades up to 7%. We crossed the tree line, admired the rough high alpine landscape, and reached the small lakeside station of Ospizio Bernina, the route's highest point at 2253 metres above sea level. We then descended to Pontresina, whose 1805 metres still left us slightly short of oxygen as we walked up to our hotels.

During dinner, Rod Muttram presented Markus and his guests with slices of their large piece of Swiss cheese from Monday and confirmed that he had indeed found a configuration where none of the holes overlapped.

Below, ascending to the Bernina Pass, one of the highest railway routes across the Alps.

Friday 1 June: old and new Albula tunnels

Inside the RhB's new Albula tunnel.

The last day of the Convention took us to Preda and inside the RhB's new Albula tunnel, which is under construction, and to the Albula Railway Museum in Bergün. To reach Preda, our train rode northwest through the original 5.8-km Albula tunnel, which connects the Albula and Engadin valleys on the Albula line connecting Chur and St Moritz. At 1820 metres above sea level, the Albula tunnel is among the highest in the Alps.

Opened in 1904, the original Albula tunnel now needs major work. To avoid a long closure, RhB decided to build a new, parallel tunnel, some 30 metres to the northeast. It is about 80% bored and will open in 2021. Cross-passages will connect the new tunnel to the old one, which in 2022 will be refitted as an escape tunnel usable by road vehicles.

We were welcomed by the RhB's Gilbert Zimmermann, who presented the history of the tunnel and the current project. Building the original tunnel was difficult. Then, as now, the harsh winters confined work to the warmer months. On 29 July 1900, 1192 metres southeast of the Preda portal, workers broke into a watery zone that filled 500 metres of the tunnel with cold, mud-like slurry.

This stopped work for 15 months. The original contractor went bankrupt. In 1901 RhB took construction into its own hands. Tunnelling from both ends under a bonus system, workers were able to regain part of the lost time and broke though on 29 May 1902, allowing the tunnel to enter service in July 1904.

In 2012, after 108 years, the tunnel's walls and drainage system needed major work. Instead of renovating the old bore, RhB decided to build a new single-track tunnel some 30 metres to the northeast. This cost about the same as renovation, avoided a long closure of the line and allowed converting the old tunnel into an escape and rescue bore for the new one. The new tunnel will also be wider to facilitate train evacuation.

Three days earlier, Hans-Peter Vetsch had reminded us that those who ignore history will make the same mistake twice. When work on the new tunnel began in 2015, the RhB were perfectly aware of one bit of history: the exact location of the slurry zone the original tunnel builders had encountered in 1900. To avoid a second slurry inrush, RhB's contractors, working from the existing tunnel at night, opened a cavern in the mountain on the new tunnel's path, just southeast of the slurry zone. From there, workers drilled numerous holes 60 metres long, parallel to the future track. Through these holes, they pumped salt water, which freezes at a lower temperature than the mountain's fresh water. This let them freeze a mass of rock extending some 2.5 metres outside the excavation profile. Once the frozen material was removed from the centre, a 1.2-metre-thick, highly reinforced shotcrete lining had to be installed within seven days.

In an emergency, 12 cross tunnels roughly 440 metres apart will let passengers escape into the old tunnel, which will be provided with lighting, a communication system and ventilation. The new tunnel's cross section will be larger to ease evacuation, but it will still be a single line. The portal stations will still offer passing loops, however. An extra block section will increase capacity.

Members inspect the construction of the new Albula tunnel.

The project is under pressure to break the tunnel through by September 2018. The IRSE therefore are most grateful that RhB stopped work for the day so that members could ride into the tunnel.

Because of the geotechnical makeup of the mountain and particularly the slurry zone, RhB decided to blast and excavate the tunnel instead of using tunnel boring machines. We were able to walk along a section of the excavated tunnel and see drilling and rock-crushing machines, the conveyor system that removes spoil, and one of the cross-passages. Despite robust ventilation, the smell from the previous night's blasting was still strong and must be very strong when work is taking place. How would it have been 120 years ago? Outside the tunnel, the spoil is sorted by size, quality and degree of contamination by the blasting that produced it. Some rock goes into the tunnel's concrete or track ballast; much of the rest will underlie a re-vegetated hill.

We then rode the most spectacular part of the Albula line. Preda is 5.2 km from Bergün as the crow flies and 417 metres higher. To keep the grade below 3.5% and minimise tunnel time for the tourists for which the line was mainly built, engineer Friedrich Hennings devised an alignment involving three spiral tunnels and numerous stone viaducts that lengthened the line to 12.6 km. It crosses over itself twice.

Albula Railway Museum

The Albula Railway Museum is next to Bergün railway station. Built in 1912 for the Swiss army, the building opened as a museum in July 2012. The 1300 square metres of exhibits guide visitors through the history of Graubünden's railways.

Our guided tour included a talk by Gion Caprez, an RhB driver. Some 600 exhibits from more than a century of railway history pay tribute to pioneering achievements in Graubünden. Decommissioned signalling panels, telephones, station clocks, historical documents and engineering plans illustrate the history and importance of the spectacular route between Thusis and Tirano, which in 2008 was designated a UNESCO World Heritage site.

"Crocodile" locomotive 407 ran through the Albula valley for more than 50 years and is now on display. A simulator in the locomotive lets visitors drive through the valley. Historical photos, texts, models and 3D animations show how engineers routed the railway through the Albula's mountainous terrain. A 1:45 model railway presents buildings, viaducts and tunnels of the RhB in the 1950s. The detail extends to the size of the boulders next to the line.

Gala farewell dinner

The Convention's final event was a gala farewell dinner in the Pontresina convention centre. After a busy week of site visits and networking, it provided a chance to relax and to thank all those who had contributed to the Convention's success.

Between courses, the Cor masdo da Puntraschigna or Mixed Choir of Pontresina provided entertainment. Led by Urs Conrad, the choir continue an old tradition of area authors, composers and choirs who write and perform songs in German, Italian and Romansh, the area's local language. Romansh is mostly spoken in the Swiss canton of Graubünden, where it has official status alongside German and Italian.

President Montigel thanked the organising committee for all their hard work in organising the week's events and visits, the sponsors for their generous contributions, and in particular Ian Harman, David Street and Francis How, as this was their last Convention after many years of successful events.

Top and above, the Albula Railway Museum contains many historic signalling systems and demonstrations.

All set for the Gala farewell dinner.