

## Driverless trains and Zurich airport

George Raymond

Forty-one members and guests of the IRSE Swiss Section gathered at Zurich airport on 11 November 2016 for an event on driverless trains and a behind-the-scenes look at the cable-powered Skymetro that connects the airport's terminals. The event's organiser was member Ernst Hedinger.

### A Swiss view of driverless trains

Wolfgang Hüppi of the Swiss Federal Office of Transport presented his agency's perspective on driverless trains. Driverless cableways have been operating in the Alps for decades. Some ore trains in South Africa drive automatically; the driver merely monitors the system. Many metro lines, including the M2 metro line in Lausanne and Paris's Line 14, on which the M2 was based, have no staff on board at all.

Today's driverless trains work on lines with homogenous rolling stock operating on a sealed-off infrastructure that do not exchange trains with the outside world. Making trains driverless on main-line railways, with their heterogenous vehicles, mixed traffic and exposed right-of-way, is much more difficult.

### Interoperability and interfaces

The main challenges for driverless trains on main-line railways, Mr Hüppi said, are rider acceptance and fear, guaranteeing free network access and interoperability, choosing the right level of automation, going beyond technical feasibility to prove a business case, and risk analysis. Technical issues facing main-line driverless trains include:

- The interface between the infrastructure operator and train operators.
- The interface between the system for driverless train operation and ETCS, both lineside and on board.
- Different braking curves of different trains.
- Different door locations on different trains, which prohibit metro-style platform screen doors.
- Using an end-of-train device to monitor train integrity, which is acceptable in North America but not yet in Europe.

Mr Hüppi said that the effect of driverless trains on riders, operators, safety, quality, capacity and costs is unknown. Automatic driving technologies must not just present a positive business case but also market advantages. Safety must remain at least as good as it is now. Automatic driving may be good



IRSE Swiss Section members overlook the Terminal E station of Zurich airport's driverless Skymetro. Just ahead is the crossover that will take the three-car train onto the other track so it can return to Terminals A and B.

for bottlenecks at nodes, allowing fewer reserves and time gains without more tracks. Trials could begin on short sections with the worst congestion. On new lines, automatic driving could allow shorter headways and easier dispatching.

Mr Hüppi encouraged engineers to not reinvent the wheel, to observe foreign practice and to seek interoperability and cross acceptance.

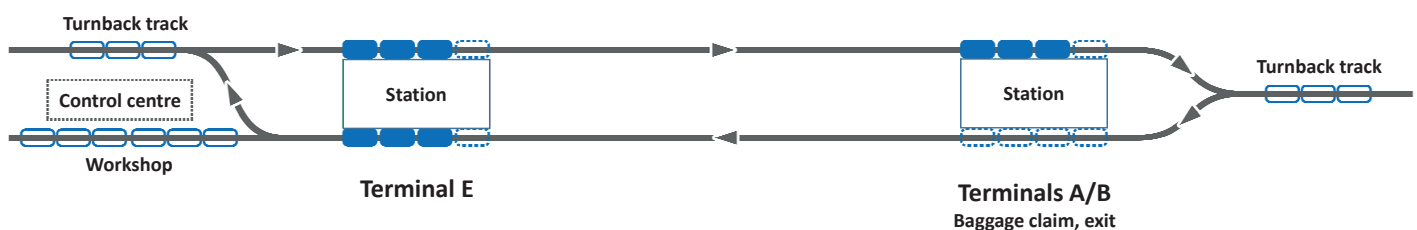
### Zurich airport's driverless train: the Skymetro

An example of a Swiss driverless train is the Skymetro, a cable-powered people mover between Terminals A/B and Terminal E at Zurich airport. A number of Skymetro staff greeted us, led by Beat Dübendorfer, who heads the internal passenger transport systems, including elevators, doors, escalators, docking bridges and the Skymetro.

The Skymetro runs in two parallel, 1138 metre tunnels. Turnback tracks beyond each station allow trains to reverse. In peak periods, three trains of three cars each run on 3.5 minute headways.

### Air pads instead of wheels

Skymetro trains do not run on rails, but rather on twin concrete strips. 28 air pads lift each car 0.2 to 0.3 mm as a train cruises at up to 48 km/h.



Track schematic of the Skymetro. Source: Zurich Airport.



A three-car Skymetro negotiates the crossover under Zurich airport's Terminal E to reverse direction.

### Complex expansion

When design of Terminal E and the Skymetro began in the early 1990s, Swissair wanted to run Terminal E and keep all their transit passengers there. Built among the runways, Terminal E doubled the number of gates at Zurich airport. The Skymetro, which runs 8 metres beneath Runway 10-28, was expected to handle mostly arriving and departing passengers, who must pass via Terminals A/B. Two-car trains seemed adequate.

Swissair went bankrupt in 2001. Skymetro started running in 2003. As local and transit passenger counts increased, airport management sought to lengthen trains from two cars to three. This led to an expansion project in 2009-2010 during which Skymetro ran at half its capacity for seven months.

### Two kinds of transit passengers

Part of the upgrade involved separating transit passengers into two flows: arrivals from airports with EU-standard security, including the US, and arrivals from other countries belonging to the International Civil Aviation Organization (ICAO) whose airport security was deemed somewhat different. Only the latter must re-pass a security check in Zurich.

Each car of a Skymetro train was assigned to one of the two security levels. New glass walls across each platform channelled passengers onto their part of the train. The control system now allows a three-car Skymetro train to stop with its middle car in either the ICAO zone or the EU zone.

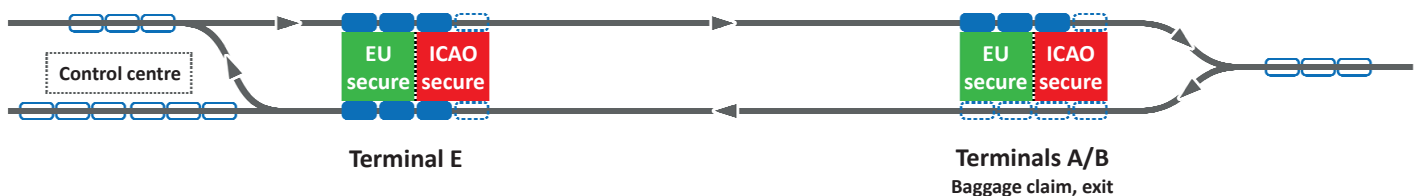
As relative passenger volumes change, the Skymetro operator can switch the middle car between the ICAO and EU zones. This requires stopping all trains. When an ICAO car becomes an EU one, security staff must inspect it for left items and stowaways.



Beat Dübendorfer shows us the Skymetro workshop as a train enters the Terminal E crossover. A separate cable loop pulls trains into the workshop. The circles show the placement of each car's 28 air pads.



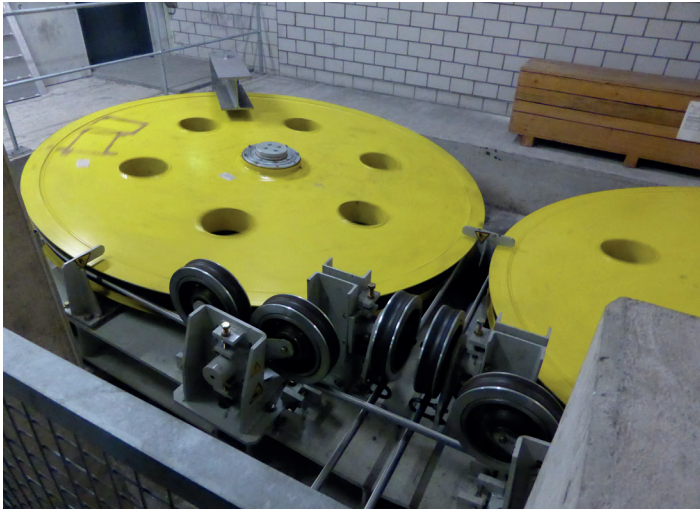
During the Skymetro's 2009-2010 partial shutdown, the airport's Gate E34 closed for six months for construction of this opening, which let cranes lower three more cars into the Terminal E station.



EU and ICAO secure zones. Source: Zurich Airport.



An empty Skymetro train arrives at the end of the Terminal E turnback track. The white pulleys are about to lower the right-hand cable and raise the left-hand cable so the train can grip it and depart in the other direction. Both cable sections are part of the turnback's cable loop.



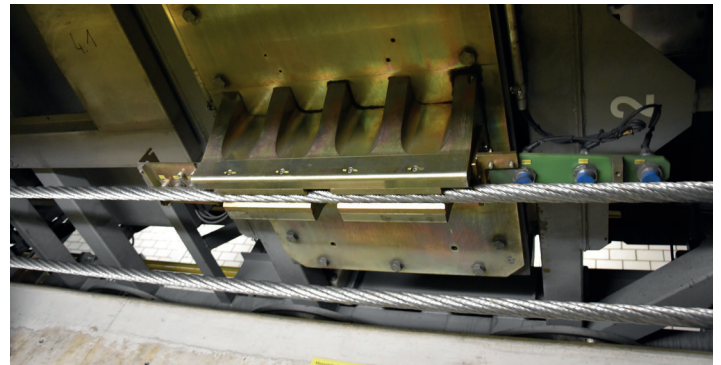
Part of the Skymetro cable winding system. A cable loop for a main track is about 2400 metres long. In 2007, a main cable wheel broke; getting a new wheel took six weeks. This led to better spare-part readiness. *Photo Daniel Pixley.*

### Focus on reliability

Zurich airport saw 26 million passengers in 2015; the total for 2016 was expected to top 27 million. A few times in July 2016, more than 100,000 passengers used the airport in a single day. Skymetro can move up to 8200 passengers per hour and direction and is essential to passengers' making their connections. To assure both safety and reliability, three parallel systems control the Skymetro trains; operations can continue if at least two of the systems are working.

The companies Poma and Otis designed and built the Skymetro, but their consortium was dissolved in 2006. Skymetro's staff of 18 work in three daily shifts. At least two people are needed to monitor operations during the day, but more are on duty for maintenance during the night shift, when trains stop for six hours.

Maintenance focuses on the workings of the cables and grips, but also on the car doors: dirt enters their mechanisms and some passengers try to hold or force the doors open.



Cable grip on a Skymetro car. In the course of a round trip, a train changes its grip to a different section of cable six times: It grips each main-line cable loop once to move between stations. And it grips each turnback's cable loop twice to reverse direction. Car grips move sideways and the cables move up and down to get the right cable into the right grip. Control room operators can monitor these operations on their screens.



Zurich airport's driverless Skymetro: We even got to ride it.

### Fire and water

The Skymetro tunnels are equipped with fire detectors, ventilators and fire doors. A ventilator at the closed end of the tunnels at Terminals A/B can either extract bad air or blow it towards the openings above the Terminal E station. The tunnels lie in ground water; pumps keep them dry.

*Photos by Henry Raymond except as noted.*

*A YouTube search for IRSE Skymetro Zurich should yield a video of our visit.*