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Autor(en): **Ansermet, Michel / Vorburger, Hans**

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Vevey transport bogies for the Fribourg railways (GFM)

Michel Ansermet, GFM operations manager
Hans Vorburger, Eng. ETS, Vevey

In the early 1980's, the Gruyère-Fribourg-Morat (GFM) railway company was faced with the problem of updating the goods transport system on their metric network. After an overall analysis, the final evaluation compared Vevey's transport bogie system to a system using trucks. The choice went to Vevey because of the numerous technical and economic advantages. Through the use of transport bogies, in Palézieux from 1982 and Bulle from 1986, the company benefits from an efficient modern transport system which contributes greatly to their overall development.

Introduction

The GFM, like many railway companies using a network with different gauges, have been faced with the problem of transferring goods between two different tracks right from the start of their existence. Operation managers, company engineers and people in other industries are continually confronted with the problem of rationalising the transfer of goods or complete wagons in order to retain, or where possible increase, the railway's share of goods transport.
The GFM are the only Swiss private company to have two different but adjoining gauges within their network. In addition, their line is linked to the Federal Railways network.
This is one of the reasons why we have chosen the GFM case as the basis for this article which describes the introduction of Vevey's bogie system to the company. It should be noted, however, that other railway companies, already equipped with our transport bogies, face similar problems, some of which we may have the opportunity of discussing at a later date.

Goods transport and transfer equipment

There are several possible methods of transporting goods from a supplier or factory to the end user and these can be used either integrally or in a complementary fashion. The options are:

- road;
- rail;
- sea and river freight;
- air freight.

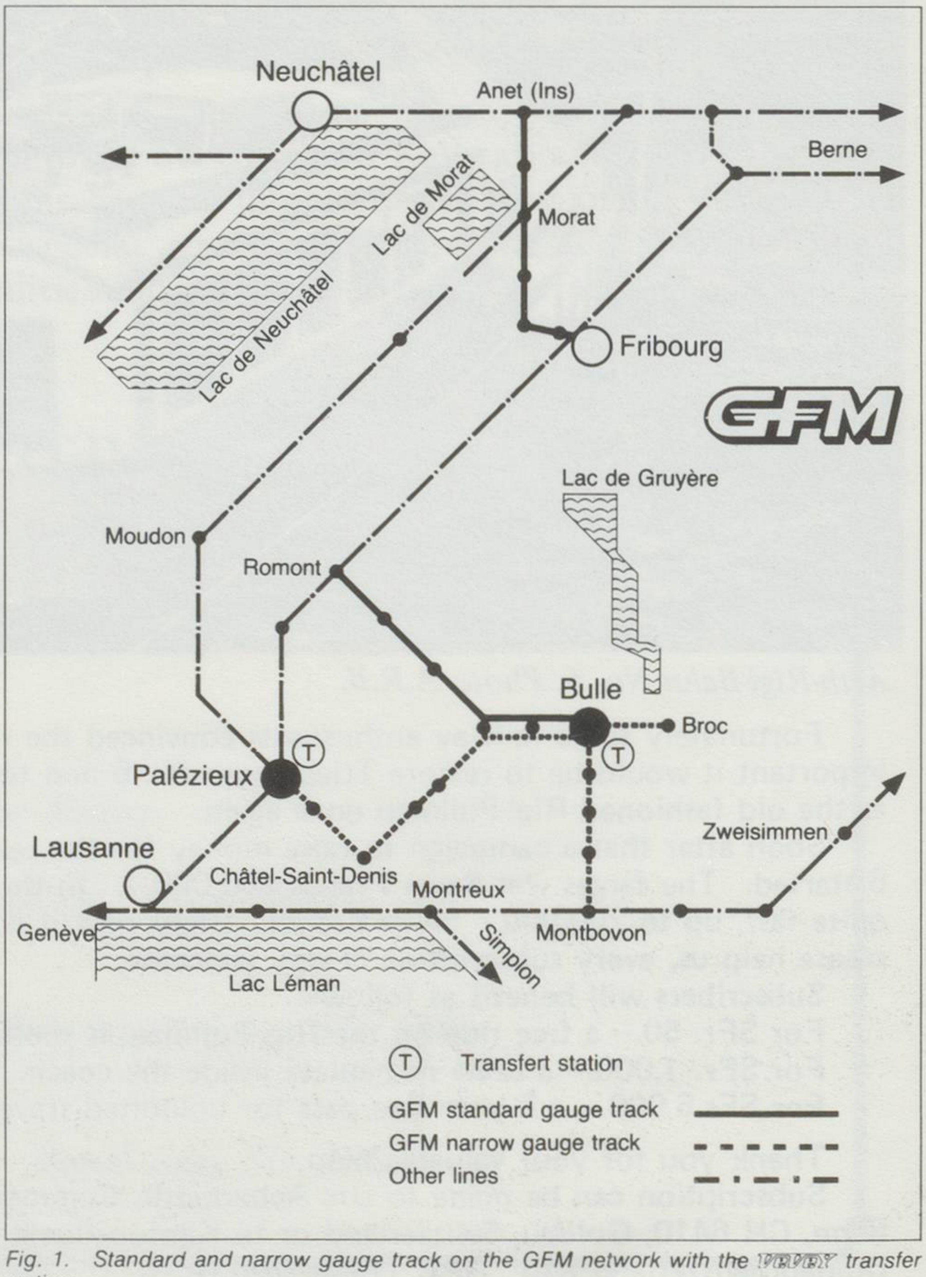

Fig. 1. Standard and narrow gauge track on the GFM network with the Vevey transfer station.

For obvious reasons, we shall only take road and rail transport possibilities into consideration in this analysis.
Suppose that goods intended for Châtel-Saint-Denis come from the Lausanne direction. The options are:

Goods departure	Transfer	Goods arrival
Road	No	Road
Road	Yes	Rail
Rail	Yes	Road
Rail (standard gauge)	Yes	Rail (metric)

Road-road transport

For short journeys and relatively low tonnage, this transport system has certain advantages despite questions that may arise concerning the ever-increasing pollution problem.

Road-rail transport

Theoretically, it is possible to load the lorry onto a low narrow-gauge wagon (Huckepack system) at the transfer point. However, this solution is economically impractical for the short distances typical of metric networks.
Another possibility would be to unload the goods and transfer them to a metric gauge wagon. This requires a lot of handling resulting in loss of time and risk of damaging the goods.

Rail-road transport

Loading a standard gauge wagon onto a road-going truck is a well-known process. This can be envisaged where road traffic is not very dense and road width allows but is in fact little used. Investment costs are very high and so is the risk of accidents. Another option, the opposite of that mentioned above, is to unload the standard gauge wagon and transfer the goods onto lorries, a procedure not really suited to bulk transport.
The options concerning systems described in the above-mentioned paragraph are of a general character and will not be detailed further in the present article.

Rail-rail transport

Goods transport and transfer systems between different gauge networks

There are several possible methods of transferring goods; these are, for memory:

- direct transfer of goods (containers, pallets, sacks, fuel, cement, etc.);
- third rail;
- loading standard gauge wagons onto metric gauge trucks;
- exchanging standard bogies for metric bogies at transfer points, where the vehicle body is lifted from one set and placed on the other;
- changing the axle gauge via a system such as VEVEY's variable track axle;
- loading standard gauge wagons onto VEVEY bogies at a transfer station.

Choice of goods transport system for the GFM

Situation before the introduction of VEVEY transport bogies

Up until 1956, any goods carried by the GFM on the metric gauge network were transferred directly. This required a metric gauge fleet of about 120 units. Problems of capacity, maintenance and investment in new metric wagons encouraged the company to install a truck transfer system at Bulle station. 20 trucks of varying types and ages, together with the creation of a transfer pit in Bulle, made it possible to meet transport needs on this network. Broc-Village, Broc-Factory, Vuadens and Gruyères stations were served from Bulle. Direct transfer was continued at Palézieux. The service to Châtel-Saint-Denis was ensured from 1979 onwards by trucks via Bulle, despite the length of the journey. Romont to Châtel-Saint-

Fig. 2. The transfer station at Palézieux.

Denis via Bulle is 37 km whereas Palézieux to Châtel-Saint-Denis is only 7 km.

GFM objectives for goods transport

At the beginning of the 1980's, GFM were faced with the problem of renewing the goods transport system on their metric network. Their objective was to maintain or, better still, increase their share of this type of transport.
The objectives were:

- serve the whole GFM metric network using all types of European standard gauge wagons;
- rationalise wagon transfer at Bulle and Palézieux;
- increase goods traffic and make it more profitable;
- open up the Gruyère and Veveyse regions to Europe and develop industrial prospects in the areas adjacent to GFM's metric network.

Criteria for the choice of a transport system

For the choice of a transport system, the company defined the following criteria:

- search for a transport system able, economically and rationally, to take standard gauge wagons of up to 20-ton-axle loading at both Bulle and Palézieux stations in a minimum of time and without complicated manoeuvres;
- a safe system which should allow 2 people to prepare a 350-ton train;
- within the network load gauge limits and respecting all Federal Transport Office requirements;
- extremely stable and having a large margin against derailment;
- accepting almost all 2- and 4-axle UIC (International Rail Union) wagons currently used on the European standard gauge network;
- respecting the 13-ton axle load limit for metric-gauge railway vehicles;
- a braking system compatible with metric gauge rolling stock (vacuum brakes);
- within the limits of the space foreseen at both Bulle and Palézieux for building the transfer installations (loading stations, truck pit, etc.).

Analysis of the possibilities and limits of transport systems using "trucks" or "VEVEY bogies"

A preliminary analysis of the choices for a goods transport system adapted to GFM's needs rapidly demonstrated that only trucks and VEVEY transport bogies should be kept on the lists for

Characteristics of the SG vehicles to be transported

The main dimensions of the wagons are approximately as follows:

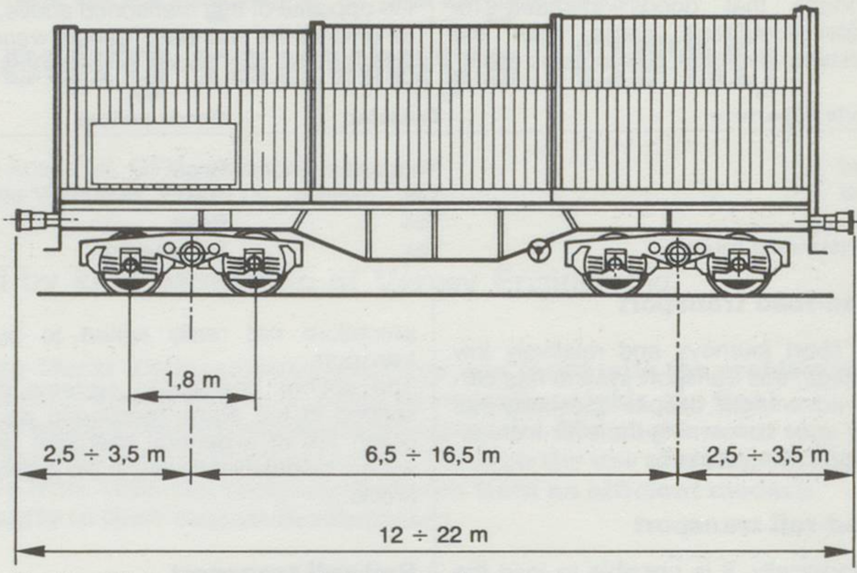

Fig. 3. SG 4-axle wagons with 20 t per axle.

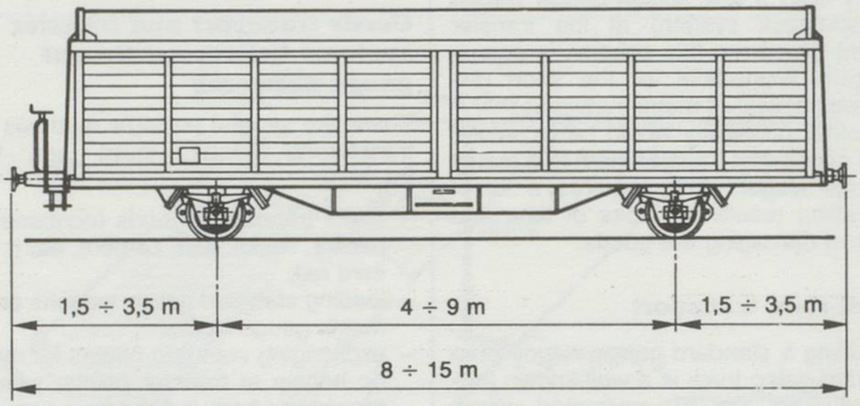

Fig. 4. SG 2-axle wagons with 20 t per axle.

Technical characteristics of the transport equipment

Different length trucks are required in order to take the various lengths of SG wagon used. For the purposes of comparison the two types shown in figures 5 and 6 will be taken into account.
The VEVEY transport bogie shown in figure 7 is able to take all current types of 2- or 4-axle SG wagons. See also Table I.

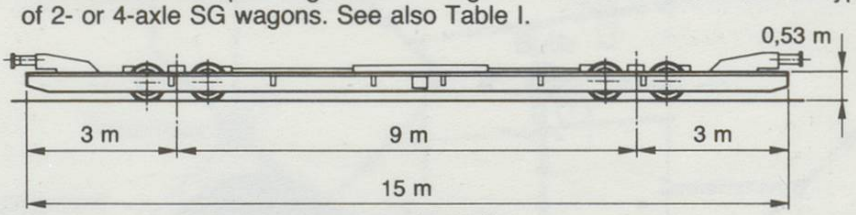

Fig. 5 *Truck A*

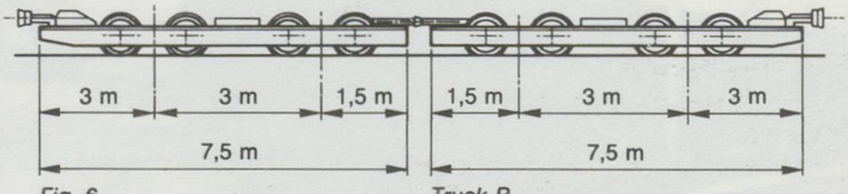

Fig. 6 *Truck B*

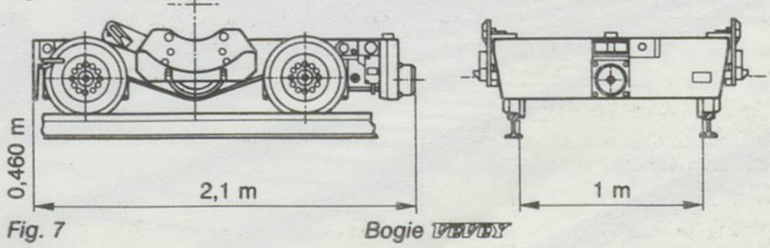

Fig. 7 *Bogie VEVEY*

final evaluation. This is why only these two are analysed and compared in this article.

Technical characteristics of the system of transfer between two different gauges

Supposing that, at Palézieux, the transfer system must take 16 standard-gauge wagon axles. In this hypotheses, as an example, five different types of SG wagon, as shown in table II, are considered.

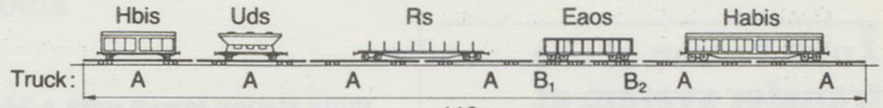

Fig. 8.

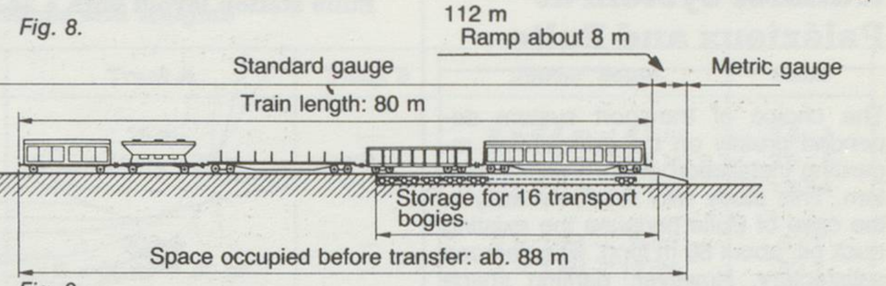

Fig. 9.

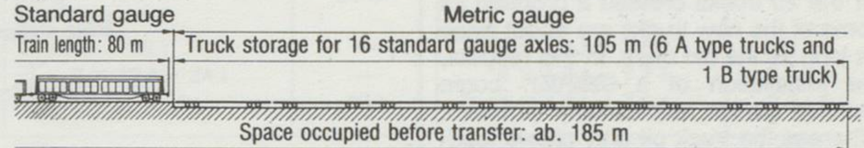

Fig. 10.

Table I

	Truck A	Truck B	VEVEY bogie
Length	15 m	2 × 7.5 m	2.1 m
Width	2 m	2 m	1.5 m
Height	0.53 m	0.53 m	0.5 m
Height increase	530 mm	530 mm	225 mm
Approx. tare	12 t	2 × 8 t	1.8 t
Payload	2 × 20 t	2 × 20 t	20 to 22.5 t

Table II

Type of wagon	Number of axles	Distance between pivots	Length of vehicle
Hbis	2	—	14 m
Uds	2	—	10 m
Rs	4	15 m	20 m
Eaos	4	9 m	14 m
Habis	4	16.5 m	22 m
Total length of SG train			80 m

Table III

Wagon	Truck A number	Truck B number	Tare
Hbis	1 unit		12 t
Uds	1 unit		12 t
Rs	2 units		24 t
Eaos		1 unit	16 t
Habis	2 units		24 t
Total tare of the trucks			88 t

Table IV

Weight hauled per loco or railcar					
Line	Slope	GDe 4/4 101 + 102	BDe 4/4 141 + 142	BDe 4/4 121	Be 4/4 131 + 132 + 133
Palézieux - Châtel-St-Denis Bulle - Broc-Village Bulle - Montbovon	32 ‰	350 t	200 t	130 t	110 t
Broc-Factory - Broc-Village	50 ‰	170 t	120 t	70 t	60 t

Transporting these 5 wagons requires 16 VEVEY bogies having a total tare of about **28.8 t**.
Transporting these same wagons using trucks requires the equipment listed in table III.
The length of the 5-wagon SG train loaded onto VEVEY bogies is **80 m** while the same train on trucks would be about **112 m long**.
The loading with VEVEY bogies is illustrated in figure 8, the one with trucks in figure 9.

In practice the truck pit is from 40 to 60 m long with additional trucks being parked on adjoining tracks linked by points, an arrangement which needs a lot of space. Preparing a transfer by truck requires about 3 times more manoeuvring than with transport bogies. The operations of integrating the trucks according to the SG wagon sequence, centring the trucks to ensure good weight distribution, fitting the heavy drawbars and anchoring the SG axles to the trucks are particularly long and difficult.

Traction and operating conditions on the network

Since the acquisition of two new GDe 4/4 locomotives, the hauled weight has been increased to 350 t. The railcars already in service are also equipped for hauling trains of wagons.
Table IV indicates the hauled load limits.
The speed of the new transport system must be increased from 40 to 60 km/h to avoid, in most cases, goods trains being passed by those running to timetable.

Installation of the transfer system at Palézieux and Bulle

The choice of transport system depended greatly on the possibilities regarding installation of the transfer system. This study was relatively easy in the case of Bulle because the existing truck pit, about 60 m long, was deemed satisfactory. However, parking space for the 20 trucks created a problem as some of the new trucks are about twice as long as the old ones. In this respect, the installation of a VEVEY bogie transfer station avoids any problem. Whereas the truck pit only allows loading or unloading of 8 SG axles, 24 bogies for 24 SG axles can be stored in the same space.
The installation at Palézieux was more difficult to achieve as the specifications required a transfer capacity of 16 axles. Even though a shortened truck pit could have been envisaged, the 100 to 120 m needed for storing trucks could not be found. Faced with this fact, the evaluation of the two systems became somewhat academic as centralising goods wagon transfer at Bulle is neither rational nor economically viable.

Technical comparison of the two transport systems

Returning to the transfer of 16 axles at Palézieux based on the same hypotheses for both systems, i.e. two 2-axle and three 4-axle wagons. In the case of Bulle suppose the transfer of 24 axles. This is possible using the VEVEY system without reloading other bogies into the station, however it is above the limits of the truck system.

Comparison of transport equipment and transfer system costs

The cost comparison takes into account some estimated values. It is therefore neither exact nor complete, nevertheless it should be sufficient to bring out the relative merits of the two systems.

Bulle station layout with a 24-bogie VEVEY transfer station

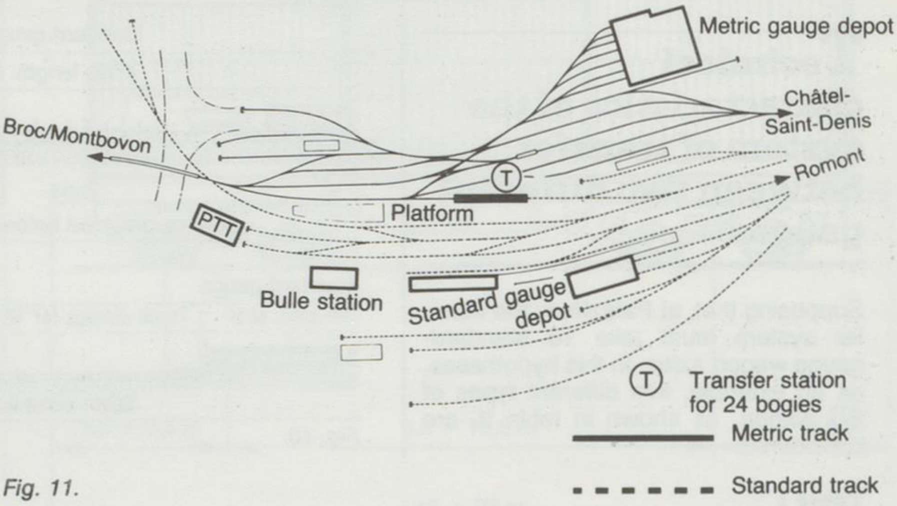

Fig. 11.

Palézieux station layout with a 16-bogie VEVEY transfer station

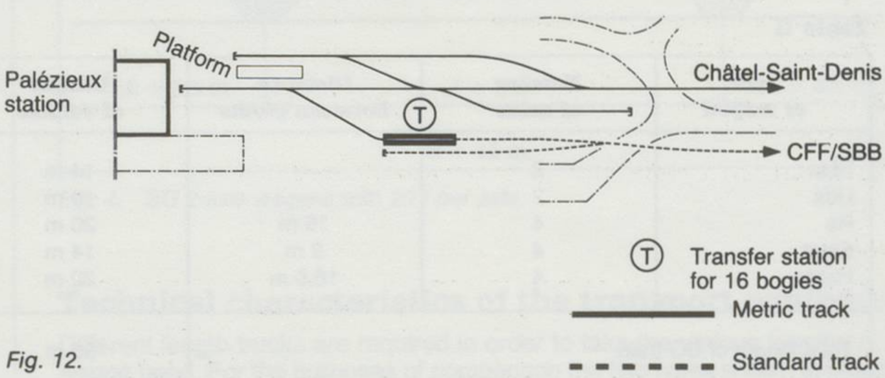

Fig. 12.

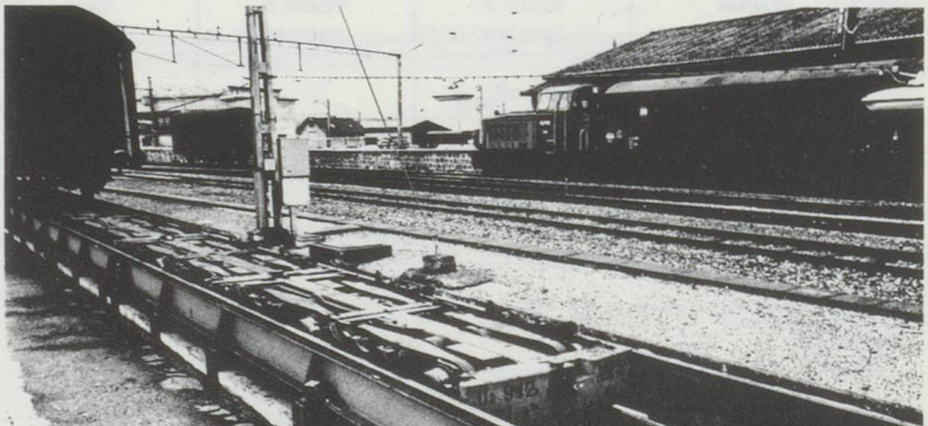

Fig. 13. The transfer station at Bulle.

Comparison tables TRUCK - VEVEY BOGIE

Table V

Comparison of transport equipment dimensions and weights

	Truck A	Truck B	VEVEY bogie	Ratio
Length (2-axle wagon)	15 m	—	2 × 2.1 m = 4.2 m	3.6 : 1
Length (long 4-axle wagon)	2 × 15 m = 30 m	—	4 × 2.1 m = 8.4 m	3.6 : 1
Length (short 4-axle wagon)	—	15 m	4 × 2.1 m = 8.4 m	1.8 : 1
Area occupied (2-axle wagon)	30 m²	—	2 × 3 m² = 6 m²	5 : 1
Area occupied (long 4-axle wagon)	2 × 30 m² = 60 m²	—	4 × 3 m² = 12 m²	5 : 1
Area occupied (short 4-axle wagon)	—	30 m²	4 × 3 m² = 12 m²	2.5 : 1
Tare (2-axle wagon)	12 t	—	2 × 1.8 t = 3.6 t	3.3 : 1
Tare (long 4-axle wagon)	2 × 12 t = 24 t	—	4 × 1.8 t = 7.2 t	3.3 : 1
Tare (short 2-axle wagon)	—	16 t	4 × 1.8 t = 7.2 t	2.2 : 1

Table VI

Comparison of transfer system dimensions and weights

	PALÉZIEUX Transfer of 16 SG axles: 1 Hbis, 1 Uds, 1 Rs, 1 Eaos, 1 Habis		BULLE Transfer of 24 SG axles: 2 Hbis, 2 Uds, 1 Rs, 1 Eaos, 2 Habis		Ratio
	Trucks	VEVEY bogies	Trucks	VEVEY bogies	
Nett weight of SG train	16 × 20 t = 320 t		24 × 20 t = 480 t		
Length of SG train	80 m		126 m		
Space occupied by the hauling equipment	105 m	—*	165 m	—*	1 : 00
Length of transferred train	112 m	80 m	175 m	126 m	1,4 : 1
Tare of the hauling equipment	88 t	28.8 t	136 t	43.2 t	3 : 1
Gross weight of train	408 t	348 t	616 t	523.2 t	1,17 : 1

* The VEVEY bogies make use of space below the standard track.

Table VII

	PALÉZIEUX		BULLE		Ratio
	Trucks	VEVEY bogie	Trucks	VEVEY bogie	
Rolling stock for haulage					
Price truck A / VEVEY bogies	240,000.—	2 × 60,000.—	240,000.—	2 × 60,000.—	2 : 1
Price truck B / VEVEY bogies	400,000.—	4 × 60,000.—	400,000.—	4 × 60,000.—	1.7 : 1
	6 trucks A + 1 truck B	16 bogies	10 trucks A + 1 truck B	24 bogies	
Total trucks / VEVEY bogies	1,840,000.—	960,000.—	2,800,000.—	1,440,000.—	1.93 : 1
Fitting air brakes to the locomotives	—	120,000.—	—	180,000.—	
Accessories and other	120,000.—	120,000.—	200,000.—	180,000.—	
TOTAL	1,960,000.—	1,200,000.—	3,000,000.—	1,800,000.—	1.65 : 1
Transfer systems					
Truck pit or VEVEY station	150,000.—	150,000.—	200,000.—	200,000.—	1 : 1
Storage track (105 / 180 m)	105,000.—	—	180,000.—	—	
Connection with points	45,000.—	—	70,000.—	—	
Accessories and other	20,000.—	20,000.—	30,000.—	30,000.—	
TOTAL	320,000.—	170,000.—	480,000.—	230,000.—	2 : 1
INVESTMENTS	2,280,000.—	1,370,000.—	3,480,000.—	2,030,000.—	1.69 : 1

Table VIII

Summary of investments

	Truck system	VEVEY bogie system	Ratio
Rolling stock for hauling 24 SG axles	4.96 mio	3.0 mio	
Transfer system for Palézieux and Bulle (16 + 24 axles)	0.8 mio	0.4 mio	
TOTAL	5.76 mio	3.4 mio	1.69 : 1

Comparison of operating costs

A comparison of operating costs cannot be carried out without taking into account the influence of all traffic operations (passenger and goods) on the network. The minimum number of persons occupied in a station depends on the degree of automatisation. Transfer of wagons using the loading/unloading station is almost automatic and lasts only a few minutes. However, forming trains with the system of transfer by trucks needs about 3 times more manoeuvring than with the transport bogies. The latter also avoid the need to handle the heavy drawbars used to link the trucks so reducing the risk of accidents to the personnel. It follows that manpower can be reduced by one or two people for the volume transported.
Due to a tare ratio of 3 to 1 in favour of the VEVEY bogies, the power of the hauling vehicle can be reduced, the hauled load increased or, theoretically, the number of locomotives and railcars reduced. The saving of dead weight compared to gross weight is about 17% which can also lead to an economy of energy.
Height increase of the SG wagons is 225 mm for the bogies and 530 mm for the trucks. This advantage leads to an improvement in safety, savings on the contact line, which can be lower, and on the tunnels which can be smaller.
In addition, due to the higher speeds of trains equipped with VEVEY bogies, the company could avoid installing passing loops on the line.

GFM's final choice

In 1981, GFM chose VEVEY bogies to equip, as a first step, the network linking Palézieux and Châtel-Saint-Denis.
Recalling the main points brought out in the technical and cost comparisons. Compared to trucks, VEVEY bogies have the following advantages:

- low weight and compact dimensions, i.e. about 2 t and 2 m instead of 8 to 12 t and 7.5 to 15 m for trucks;
- no need for heavy drawbars between the vehicles as the standard gauge vehicles remain coupled; the bogies are pulled along by the SG axles;
- no limit to the length of wagon which can be transported;
- an increased operating speed of up to 60 km/h instead of 40 km/h with trucks;
- greater stability in the transfered wagon due to the lower height increase;
- greater safety and speed during loading and unloading operations;
- substantial savings on investment; two transport bogies which replace the equivalent of one truck cost only half as much.

Finally, the system, developed by VEVEY and now in service with a number of companies, is already widely proven.
Only one point amongst the criteria established by the GFM could not be respected. In view of the bogie's compact dimensions, it was impossible to fit vacuum braking equipment as is used on all other GFM narrow gauge rolling stock. The bogie air brake must therefore be fed via a compressor installed in the new locomotives or in an intermediate narrow gauge wagon. However this inconvenience is minimal compared to the advantages listed.
The complete installation for traffic between Palézieux and Châtel-Saint-Denis was commissioned in 1982; the introduction of the system on the remaining metric network, i.e. the Bulle-Broc and Bulle-Montbovon lines, was carried out later and put into operation in the autumn of 1986.

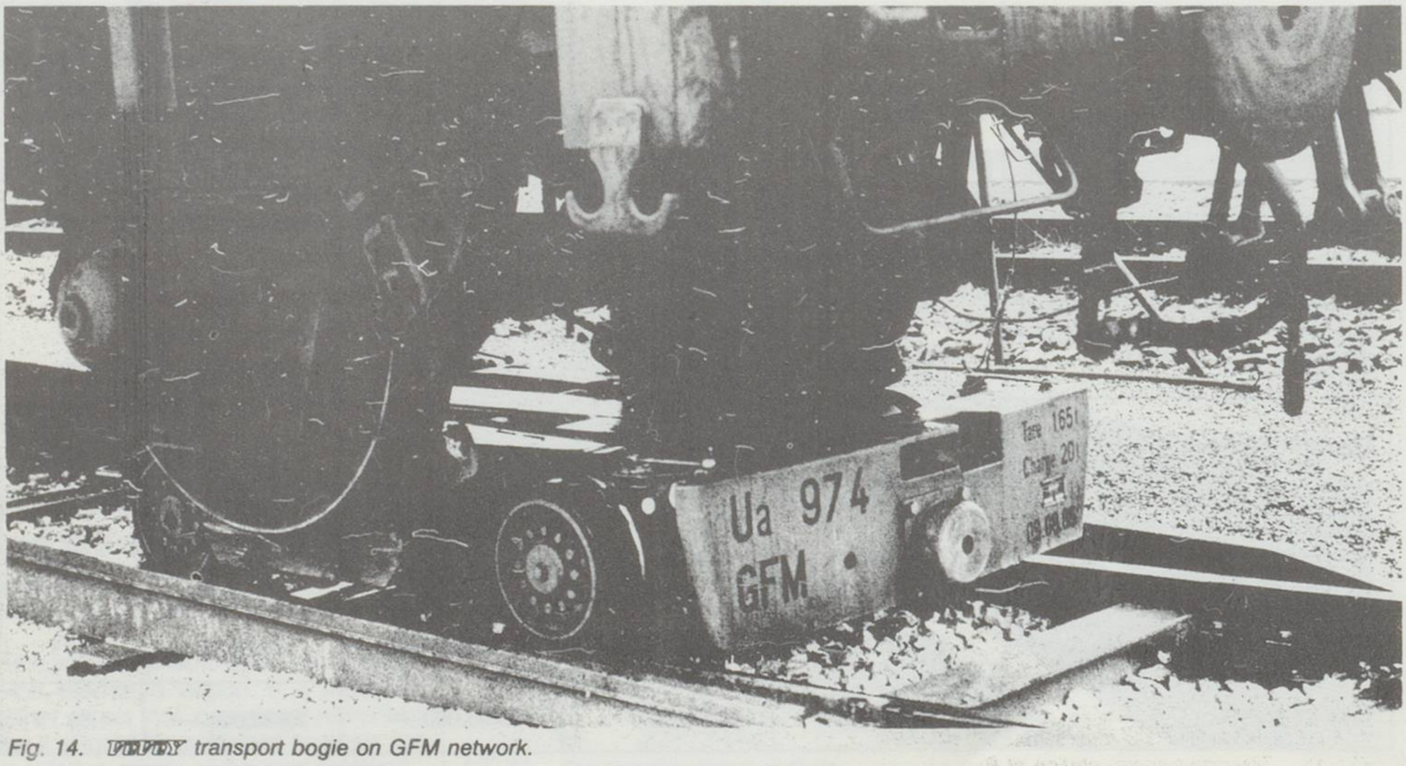

Fig. 14. VEVEY transport bogie on GFM network.

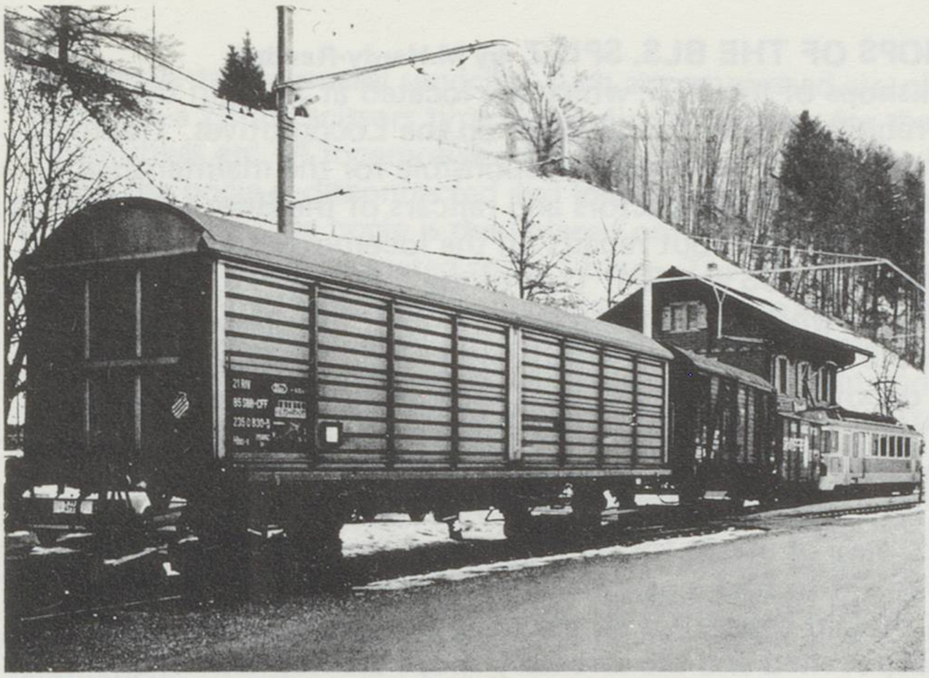

Fig. 15. Transport of goods by means of VEVEY bogies on GFM network.

Results obtained to date

Introduction of the bogie system in two stages was found to be a wise move. The results obtained from 1982 to 1985 on the first section were extremely positive. The personnel responsible for the installation at Bulle from 1986 could be correctly trained and all preparatory work on the hauling vehicles, enlarging tunnels and rebuilding the bridge at Broc, was undertaken with full knowledge of the facts. The transfer system had to be installed in a few days and operations restarted with bogies in place of the trucks as quickly as possible. In fact, transport of goods by rail was only interrupted for one week-end.

GFM have already noticed that goods traffic has greatly increased. The reserve of bogies at Palézieux has already practically fallen to nothing. At Bulle, it was planned to replace 20 old trucks, only 12 of which were in regular service, with 20 transport bogies. In view of the Palézieux success, the Bulle order was increased to 28 units. However, 6 months after coming into use, it became evident that the total fleet of 44 bogies in service needed to be increased by 8 units for technical reasons and to maintain a reserve, in spite of a higher turn-around.

Conclusions and plans

The objectives set by GFM have largely been reached. The company now has a new wagon transport system, modern and efficient, which fully satisfies rail-based goods distribution needs. Many new and older industries benefit from this transport set-up and contribute to maintain or even create employment. The main products carried are: wood, cement, fertiliser and chocolate. However, the possibility of serving the whole region with modern, specialised, high-capacity wagons gives hope of openings in other sectors. The continuing existence of the company, solidly based on both passenger and goods transport on its narrow gauge network, is now assured.

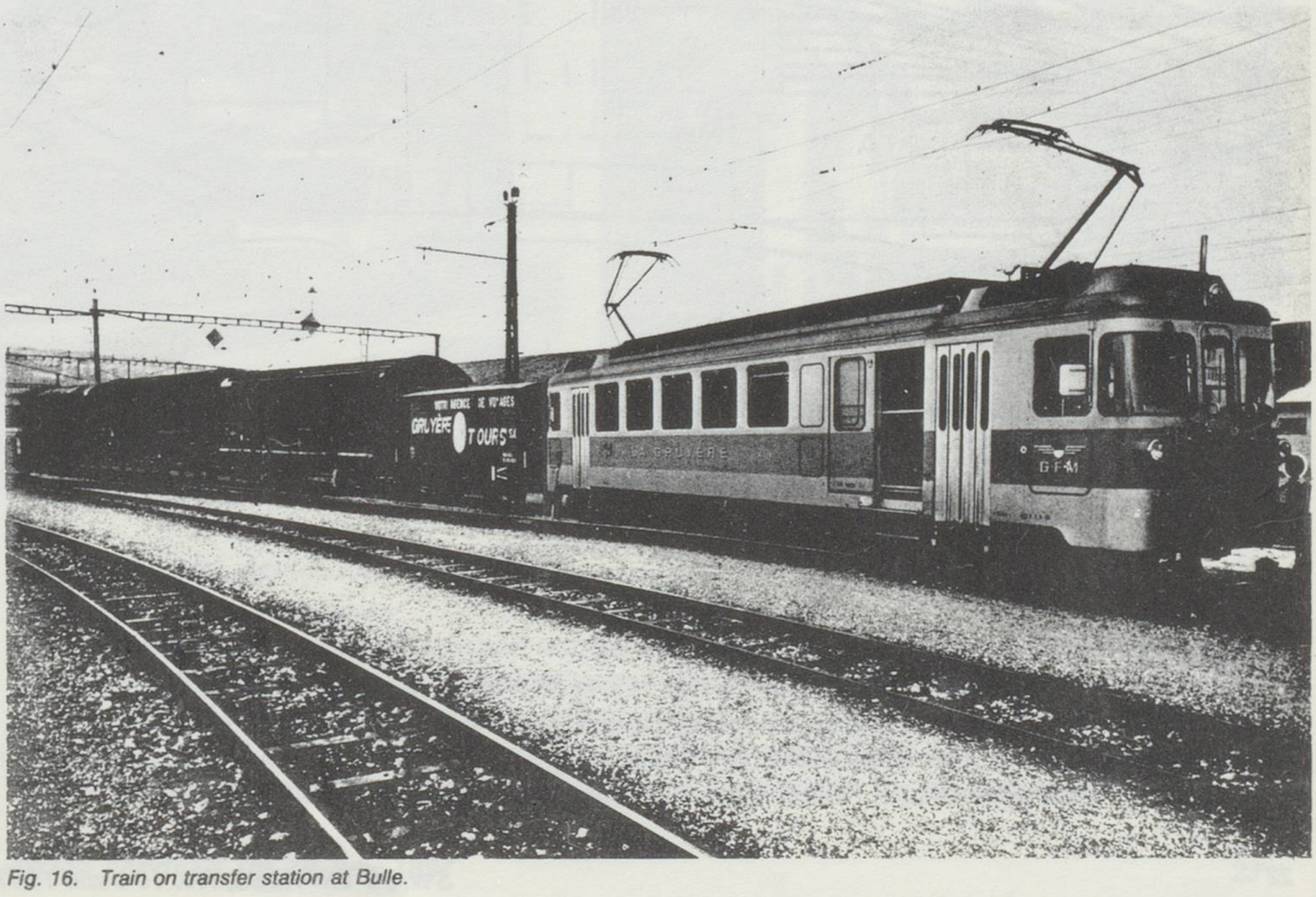

Fig. 16. Train on transfer station at Bulle.