

SCANIA ARTICULATED PUSHER BUS



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INITIAL TRIALS OF ARTICULATED PUSHER BUS

A NEW SWEDISH BUS – THE SCANIA REAR-ENGINEED ARTIC

Belgian Jonckheere Body Provides Smooth, Silent Travel

● **Scania-Bussar** have now unveiled a completely new articulated pusher bus based on the **Scania BR 112** standard chassis. Thus, this is a conventional articulated bus with the difference that the engine is mounted at the rear. The body is supplied by the Belgian coachbuilders **Jonckheere**.

● **The Scania BR 112 articulated bus** is equipped with a **Scania DS 11** diesel engine rated at 184 kW (250 hp) and a four-speed fully-automatic gearbox. The new vehicle, which differs from the majority of other articulated buses in that the engine is mounted at the very rear, will be marketed in the Nordic countries and in other leading European markets as from New Year 1980. After the **Volvo B 58** articulated bus, this is the second Swedish bus to be built with a Swedish-made chassis and rear-mounted engine driving

double rear wheels through a rigid axle. It is a newcomer to the family which originated with the West German **VÖV** and **Mercedes Benz** buses—vehicles which attracted major attention. Now, we may also have an articulated bus which is an attractive proposition for use in long-distance traffic.

● The Scania BR 112 bus chassis on which the complete Scania BR 112 municipal bus is built, is divided into a control module and a drive module. The former includes the driver area, while the latter carries the cross-mounted engine, gear-box, final drive gear and rear axle gear housing.

● The location of the drive unit has made it possible to provide environmentally-beneficial sound insulation and to make the unit easily accessible for repairs and servicing.

● Since the chassis is designed to

carry a self-supporting body, it can be easily adapted to meet different requirements with regard to overall length, floor height, etc.

● **The articulated bus is driven through the rearmost axle.** This means that bodywork and chassis components can be standardized with respect to other two-axle buses with rear-mounted engines. Each of the two rear rigid axles on the articulated bus is equipped with double wheels, enabling the same size of tyre to be used on all wheels. According to Scania, the use of **rigid middle and rear axles eliminates the tendency of the rear end to swing outwards when cornering—a common characteristic of articulated buses with steered third axles.**

● In the articulated bus version, the Scania BR 112 chassis is supplemented by an intermediate section and articulated joint de-



● *Left: The new Scania articulated pusher bus with rigid middle and rear axles as seen from the front. Right: The interior of the bus showing the comfortable, fabric-upholstered semi-tourist seats which, like the body, bear the unmistakable Jonckheere stamp.*
 PHOTOS: SCANIA-BUSSAR.

signed by the German firm of **Robert Schenk GmbH**. A total weight distribution of 6 tonnes on the front axle at approx. 10 tonnes on each of the other two axles is achieved by locating tanks and other accessories at the articulated joint.

● **The weight distribution reduces the normal "snaking" tendency of articulated buses at high speeds,** according to the makers.

● Braking distribution is facilitated and improved by the location of the engine above the drive axle, and by the retarder incorporated in the automatic gearbox which may remain engaged even under winter conditions.

● **The Jonckheere Trans City** is a newly-designed body marketed in Sweden by **ELG Bus Products** of Katrineholm. The overall length is 17.4 metres and the bus accommodates 70 seated and 50 standing passengers.

● The frame of the body is constructed from steel sections treated with an anti-corrosion agent. The low floor is on two levels separated by insulation. The roof is of galvanized steel while the outer cladding is of stainless steel. Crash protection is to Swedish

standards and the roof is provided with three hatches which can also serve as emergency exits.

● The heating equipment consists of a **Dreiha** defroster unit and **UWE** type heating element combined with an additional **Webasto** heater. The articulated section is provided with air intakes and outlets to ensure a satisfactory level of heating in the rear of the bus.

● The Scania BR 112 is available with a range of engines, gearboxes and transmissions, and can therefore be adapted to carry either light or heavy bodies as necessitated by different types of applications. The Scania DS 11 supercharged diesel engine driving a Scania four-speed fully-automatic gearbox has been selected to power the new articulated bus.

● The first model of the Scania articulated pusher bus is obviously a prototype, and is presently undergoing a comprehensive series of trials which started in June 1979 when the bus was unveiled at the international conference on local traffic problems (held in Helsinki under the auspices of **UITP**) and will continue until the end of the year. (In our pictures, the bus is seen in the livery of **SLT, [Sö-**

dermanlands Läns Trafik AB] who are conducting the trials.) The **SLT**, who in general terms expect to require a large fleet of articulated buses, have ordered several vehicles of this type according to Managing Director **Christer Fridell**.

● The September 1977 **Frankfurt Fair** was one of the events which stimulated Scania's interest in articulated pusher buses when it was realized that the new Scania **BR 112** chassis would be ideal for this design of bus. It is possible that Scania, with this new, stable articulated pusher bus, may also break into the long-distance bus market in which several companies have, down through the years, been interested in the economical possibilities of the pusher type but—rightly or wrongly—have feared to tread because of the technology involved. The increased attention to the use of three-axle buses for long-distance traffic is surely one clear indication that there is a need for higher individual bus capacity in this type of application.

RAGNAR THÖRNBLOM ON SCANIA'S ARTICULATED PUSHER BUS:

RISK OF JACK-KNIFING MINIMIZED EVEN WITH RETARDER

● The Volvo articulated bus with the engine in the middle is familiar to us. In the early 1960s, Scania-Vabis built a front-engined articulated bus with a Norwegian-built body which is still in passenger service in Örebro. Now, Scania-Bussar presents the latest type of articulated bus, namely the rear-engined or pusher articulated bus as it is also known. West Germany was the first country to adopt this design which is now about to compete with Volvo on the Swedish articulated bus market. What are the views of Scania-Bussar on the pusher articulated bus, its design, its advantages and disadvantages? The answers were contained in a paper read by Scania's Ragnar Thörnblom to the UITP conference held in Helsinki from 10-16 June 1979 in conjunction with the unveiling of the new Scania BR 112 articulated bus with the Jonckheere Trans City body. We reproduce below the greater part of Ragnar Thörnblom's address, i.e. the section dealing with the vehicle engineering aspects of articulated bus design. **The editor.**

● Articulated bus technology may be classified under a number of headings which are of interest for the purpose of technical evaluation, and in the context of which there is a considerable divergence of opinion as to the choice of design solutions.

● For example, the following classification may be made:

- [1]. Flexibility
- [2]. Performance and environmental characteristics
- [3]. Standardization of components with respect to two-axle buses in the same type of service
- [4]. Passenger and driver comfort
- [5]. Drive geometry
- [6]. Weight distribution
- [7]. Roadholding
- [8]. Anti-jack-knife protection

● Let us make a brief general review of these points one by one.

● Articulated buses can be used



● According to Scania, rigid rear axles on the new artic pusher bus minimise the risk of jack-knifing even with a retarder.

for practically all types of service. This means that they must meet a wide range of specifications. Low floors are required for buses in urban traffic whereas raised floors with all the seats facing forward and large underfloor baggage compartment may be specified for vehicles used in unscheduled traffic. With gross weights of 25 tonnes and over, drive line components capable of meeting the requirements of good acceleration and high speed must be readily available. Buses with adequate sound insulation must be available for applications where there are stringent noise emission regulations.

● Public transport companies with large bus fleets, primarily those operating city and suburban routes, require that their articulated buses have a high degree of component commonality with their two-axle vehicles. In addition, service and maintenance procedures should be the same for all buses, as far as possible. Drivers and passengers appreciate familiar surroundings in a bus, irrespective of type. This is especially true of the driver area, interior fitting, steps and doors. Features such as suspension, heating and ventila-

tion should also be similar. Drivers and garage staff require the articulated bus to be responsive in traffic and capable of negotiating the same openings as a two-axle bus without having to pay extra attention to bus movement. Pulling into or away from stops should not require excessive space and should not constitute a hazard to other road users or to passengers waiting at the stop.

Retarder Must Not Cause Jack-knifing on Slippery Road Surface

● Weight distribution in an artic bus should be designed to ensure high drive wheel tractive effort and optimum distribution of the braking effort. The retarder should operate without causing jack-knifing on slippery road surfaces. High axle weights are important to ensure that the high passenger capacity of this type of vehicle is utilized to the full. The travelling characteristics of the artic bus must be such that the driver and passengers feel that the bus is a safe and stable vehicle at all speeds irrespective of road surface conditions. **The bus must be**

built to prevent the occurrence of uncontrolled movement between the two sections of the vehicle.

● In many ways, the configuration of the bus must be a compromise between a variety of requirements, some of which are more or less self-contradictory. It is this process of compromise which gives rise to different design philosophies. On the basis of our choice of the BR 112 chassis for the articulated bus, I now propose to show how we at Scania weighed

the pros and cons of different solutions and compromises against the general requirements mentioned earlier.

● We believe that flexibility in operation can best be achieved by using a rear-engined chassis which facilitates a design featuring low floors, a comfortable boarding height, integral bodywork without true chassis members and adequate space for passenger circulation without the obstruction of an engine cover of also affording the

option of a raised floor with generous underfloor baggage compartments. Based on these criteria, the obvious choice was the BR 112 chassis which also more than satisfied the performance and environmental requirements. The low noise level (77 dB[A] as per ISO 362) is an established fact, while the engine and gearbox performance specifications are not only adequate but are capable of being increased to deliver even higher outputs—an aspect which will be evaluated in greater detail when testing the first bus.

● Two-axle, rear-engined buses are the commonest type used by modern public transport companies operating city and suburban services, and we can see a trend towards the increased use of this type of vehicle, mainly because of two factors, namely the requirement of low boarding height and the demand for reduced interior and exterior noise which can best be met by an engine mounted at the rear of the vehicle. Combined component standardization and good serviceability: these requirements are persuasive factors in the choice of the BR 112 chassis as the basis of an articulated pusher bus. As far as driver and passenger comfort are concerned, the problem of interior noise has already been dealt with. It should also be pointed out that since it is impossible to eliminate chassis noise in the floor area at the point of articulation, the engine and transmission should preferably be located as far from this point as possible.

● In other respects, the achievement of a high degree of comfort requires the use of a full pneumatic suspension in which the suspension characteristic of the three axles are interbalanced using suitable air bellows and shock absorbers. The pneumatic suspension of the BR 112 is ideal for this purpose.

● In terms of drive geometry, a distinction is made between an articulated bus with a link-steered third axle and one with a non-steered third axle. Both solutions have their advantages and disadvantages. In practice, a steered third axle precludes the use of a rear-mounted engine, at least if the third axle is to be the driven axle which would be the logical approach for purposes of standard-

THE NEW ARTICULATED BUS Remarkably silent and stable even at high speeds

● For the first time in my life, I have ridden in an articulated pusher bus or, in other words, an artic bus with a rear-mounted engine (never having had the opportunity of travelling in any of the German buses of this type). However, in Helsinki at the beginning of June, I made the acquaintance of the new Scania-Bussar BR 112 artic bus equipped with a body built by the Belgian firm of Jonckheere. Although it is naturally difficult to form definite opinions on the basis of a short ride, these were some of my observations:

● Even at speeds as high as 110 km/h, the bus behaved in a particularly smooth, stable manner on the road. In fact, I had no impression of riding in an articulated bus. Cornering seemed extremely good despite the rigid rear axle, while in addition to the customarily successful damping of exterior noise characteristic of the Scania BR 112 rear-engine chassis, Jonckheere appear to have been truly

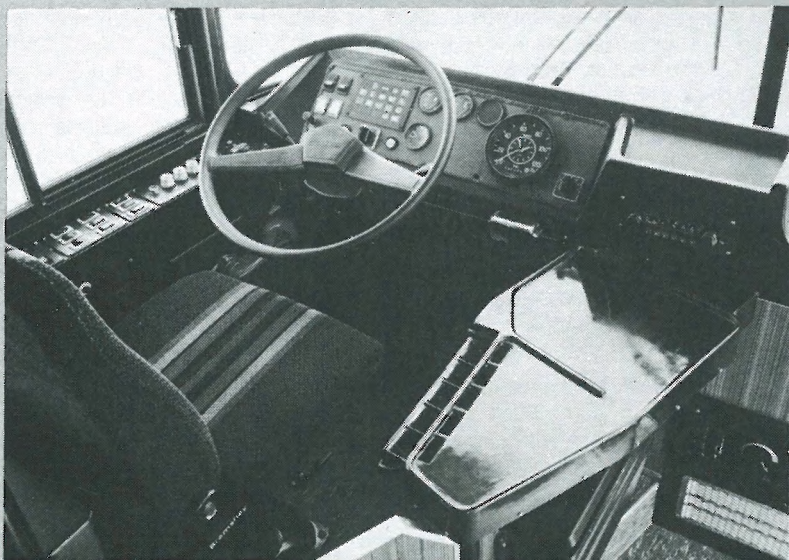
successful in suppressing interior noise. Even in the back seat, the bus was remarkably quiet under all conditions, and the additional insulation of the rear-mounted engine from the interior must be regarded as a success.

● The body, with its large, bonded windows, gave (as is usual with this type) an impression of strength, stability and silence, combined with a relaxing sense of space and light.

● On first acquaintance, the only adverse impression was the quite pronounced noise from the articulation "bellows". It is obvious that when all other sources of noise have been practically eliminated, this particular source of noise leakage must become more obvious! Perhaps this is also a source of noise which is normally drowned out in other artic buses. However, I think that more may have to be done on production models to eliminate the penetration of engine, wheel and driving noise at this point. Can sealing be carried out or can some type of additional material be used to absorb more noise?

● However, the stability of travel offers new hope for the articulated bus as a means of long-distance, high-speed travel. It remains to be seen whether Scania-Bussar can produce a model which will convince the transport companies of its capabilities in this respect. Because in terms of traffic economy, the articulated bus must be found a role in long-distance applications, as well as in tourist and scheduled services in this country.

G. W.



TECHNICAL SPECIFICATIONS:

Basic chassis	Scania BR 112	Front axle	Scania AM60.
Middle section of chassis	Schenk with standard articulated joint. The middle section is designed for the standard front and rear sections of the standard Scania BR 112.	Middle axle	Scania AT90 rigid axle with twin wheels.
		Rear axle	Scania AD90 rigid axle with twin wheels.
Engine	Scania DS 11 supercharged vehicle, max. rating 184 kW (250 hp) at 2 200 rev/min and max. torque 995 Nm (101 kgf m) at 1 300 rev/min. All specifications as per DIN 70020.	Electrical system	24 V system, with alternator 80 A 160 Ah batteries.
		Steering	ZF hydraulic power steering.
Gearbox	Scania GAV 762 four-speed, fully-automatic gearbox with retardation programme consisting of down-changing through three mechanical gears combined with engine brake.	Suspension	Full pneumatic suspension on front and rear axles. Pneumatic suspension with longitudinal, load-bearing torsion strut on middle axle. Total of 8 shock absorbers.
		Tyres	11R-22.5 all round.
Transmission	Scania RV 654 single-stage reduction gearing, ratio 3.73:1, giving a maximum speed of 111 km/h.	External noise level	Enclosed engine compartment gives max. 77 dB(A) as per ISO 362.
		Kerb weight	16 300 kg.
		Gross vehicle weight	26 500 kg.
		Total length	17.41 metres.

ization and design simplification. A steered driven axle with twin wheels would be a technically complicated and expensive design, as would a transmission between a rear-mounted engine and the middle axle. The net result is that if the engine is mounted at the rear, the third axle must be non-steered.

● **The following characteristics of the artic pusher bus with a non-steered third axle should be noted when comparing it with an artic type with a link-steered third axle:**

A. Since the swept area is larger, the bus must be shortened by one row of seats in compensation. In practice, the loss of passenger capacity is limited to four places (3 seated and 1 standing) since the pusher artic does not require the distinctly tapered rear which distinguishes the type with a link-steered third axle.

The tapered rear on the latter type also represents an attempt to counteract the pronounced tendency of the rear end to sweep outwards during sharp cornering, as when negotiating street corners in lanes or pulling away from stops (in which case the rear end tends to sweep the pavement). This behaviour constitutes a serious hazard to pedestrians and other road users, in addition to which the movement is difficult for the driver to control since he cannot see the critical corner while carrying out the manoeuvre.

● The articulated pusher bus does not suffer from this disad-

vantage. Opinions vary as to which is the lesser and more acceptable disadvantage. Is the wider turning sweep of the pusher type preferable to the wide out-sweep of the rear of link-steered articulated bus? In our opinion, the answer is definitely yes, especially since the turning sweep of the pusher bus does not reach maximum until the bus is half-way or more around the turn.

● Thus, if the main dimensions of the pusher type are correctly chosen, the bus can maintain roughly the same drive geometry as a 12-metre two-axle bus at road junctions and corners under normal driving conditions. The drive geometry of the BR 112 therefore satisfies this criterion, although in certain situations it may occupy more space on the road. The bus has obviously been designed to maintain a stabilized turnsweep within an outer radius of 12 metres and an inner radius of 5.3 metres in conformity with the new draft Nordic Regulation.

B. The weight distribution in the pusher artic offers excellent road grip. Even when empty, sufficient weight on the driven axles to ensure adequate grip is provided by the rear-mounted engine.

● **On the other hand, the weight on the centre axle will be relatively low so that, when building the vehicle, careful attention must be paid to the location of components to ensure that the axle weight at this point is sufficient to eliminate the danger of jack-knif-**

ing. The weight exerted by the rear section of the bus at the point of articulation is also an important design consideration. A sufficient downward (positive) force is required to minimise the risk of poor stability and "snaking".

C. Axle weight distribution shall be such that the highest axle weight, and hence the highest braking force, is exerted on the rearmost axle. The BR 112 has this characteristic and **since the retarder operates on the rearmost axle, the design is safer than one which features a driven middle axle, in which the retarder will increase the danger of jack-knifing on slippery roads.**

● Jack-knifing is best inhibited by optimizing the relationship between the weight on the middle axle, the distance between the point of articulation and the middle axle, the compensation of certain angular movements of the articulated joint and the mounting of the middle axle in the chassis.

● **The basic vehicle design should be such that special safety devices are not normally required to prevent jack-knifing or "snaking" at high speeds.** However, means of assisting the driver to retain control of the vehicle where driving conditions so demand should obviously be available.

● **Since it is our intention to test various safety devices during this autumn and winter, we are not prepared, at present, to specify our final solution**

RAGNAR THÖRNBLÖM