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Some labour implications of technological change in rail and air transport

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A variety of serious difficulties and far-reaching changes have affected rail and air transport in recent years. Although the context was different in each case, railway and airline managements have reacted in similar ways by intensifying their policies of technological innovation. The following article attempts an appraisal of these policies and of their impact on labour in these two industries. The first part gives a brief account of the major economic difficulties that have induced railways and airlines to introduce new technologies, while the second shows the major applications of these technologies; the third part discusses some of the implications for the workforce and industrial relations, and the fourth contains some tentative conclusions on future trends.

I. The economic context

Rail transport

Since the 1960s railways have lost ground to trucks and private cars because the rigidity of their networks and services and the long lead times involved in new investment have prevented them from capturing the new business created by the geographical dispersion of light and service industries and populations away from the traditional centres of heavy industries. Being still dependent for much of their revenues on such important clients as the coal and steel industries, the railways were also hit hard by the economic recession of the late 1970s and early 1980s.

Table 1 shows the modal distribution of inland freight transport in four countries. It illustrates the decline of the railways against the growth of road transport, in particular, between 1963 and 1984. The trends are generally more pronounced in terms of tonne-kilometres, demonstrating how trucks have replaced railways in long-distance transport. The trends for the Federal Republic of Germany are exaggerated by statistical distortions.

* International Labour Office.

Table 1. Modal distribution of inland freight transport, 1963 and 1984 (%)

Country		1963				1984			
		Rail	Road	Waterway	Pipeline	Rail	Road	Waterway	Pipeline
France	A	18.9	72.9	5.7	2.5	...	...	...	...
	B	55.7	31.3	9.6	3.4	33.3	47.9	4.8	14.0
Germany	A	51.0	18.6[1]	26.0	4.4	9.6	80.2	7.9	2.2
(Fed. Rep.)	B	46.6	21.0[1]	28.8	3.6	24.1	51.7	20.8	3.4
Netherlands	A	7.8	53.5	36.7	2.0	2.7	57.8	34.9	4.6
	B	12.6	23.0	60.8	3.6	...	...	...	...
United	A	15.1	83.4	0.6	0.9	...	...	...	...
Kingdom	B	30.2	68.4	0.3	1.1	11.9	80.5	0.2	7.3

A = Tonnes carried; B = Tonne-km.
[1] Excludes short-distance road transport. Total road transport is obtained by doubling A and increasing B by one-third.
Sources: United Nations Economic Commission for Europe: *Annual Bulletin of Transport Statistics for Europe*, 1971 (Geneva, 1972), table 3; and ibid., 1984 (Geneva, 1985), table 3B.

A look at the major commodities carried by each mode in the EEC countries reveals that in 1983 road transport carried 75 per cent of manufactured products, 69 per cent of chemicals, 65 per cent of processed foods, 60 per cent of agricultural produce and 43 per cent of metal products. Railways carried 36 per cent of coal and coke shipments, 32 per cent of metal products, 25 per cent of ore shipments and 22 per cent of fertiliser shipments, but were no longer dominant in any market.[1]

Inflationary pressures and the two energy price hikes of 1973 and 1979 raised operational costs in all branches of transport. For the very labour-intensive railways, inflation meant a sharp increase in staff costs, which accounted for between 60 and 90 per cent of operational costs in 1978-82. Diesel fuel prices for railways in the United States rose from 10 cents per gallon in 1973 to one dollar in 1981, and currently stand at around 80 cents per gallon. Every one-cent increase in the fuel price means an additional $33 million on the annual fuel bill.[2]

Sluggish economic growth during the late 1970s and early 1980s has induced many governments to fight inflation and recession by reducing public spending and encouraging private enterprise. For the nationalised railways, whose budgetary deficits reached alarming proportions in some countries (e.g. the Federal Republic of Germany, Japan and the United Kingdom), that meant a cut in government subsidies and pressure to trim costs or to privatise. In the United States, while deregulation of the railways gave them considerable freedom to adjust their haulage tariffs to the market trends and eliminated the artificial barriers which had previously held tariffs down, it also compelled railway managements to keep operational costs, especially staff costs, down to the lowest possible level.

Air transport

Airlines, too, were hit by the economic recession from 1979 onwards as passenger and freight revenues declined. Although airlines faced virtually no competition from other modes of transport except over short distances, deregulatory policies in the United States introduced competition over the North Atlantic routes which, compounded by high interest rates on the dollar, adversely affected airline net revenues until mid-1983; from a record surplus of $1,500 million in 1978, net revenues of international scheduled services plummeted to record deficits of $1,900 million in 1980 and 1981.[3]

Furthermore, a fivefold increase in jet aviation fuel prices, from 20 cents a gallon in 1975 to around one dollar in 1980, meant that fuel costs rose from 18.8 to 27.0 per cent of operating costs over the same period. Airline staff costs almost doubled, from $3,243 million to $6,387 million, although their share of total costs declined from 32.6 to 28.5 per cent, again between 1975 and 1980.[4]

In the normal circumstances of a regulated sector the airlines could pass any rises in labour or other costs on to the consumer with relative impunity, or make ends meet with public subsidies. However, reduced government support and the deregulation of the air transport industry in the United States since 1978 have introduced competition into what was previously a sheltered sector, and have compelled managements to cut their expenditures simply in order to survive. Deregulation, compounded by falling traffic revenues and higher costs, has forced several airlines into bankruptcy. Examples are Braniff and Laker Airlines, which overextended their routes and cash resources, and Continental, which for the first time in the United States invoked the provisions of Chapter 11 of the federal Bankruptcy Code in order to renegotiate its labour contracts.[5]

II. Technological innovations in rail and air transport and their impact

It was against this background that railways and airlines intensified their policies of introducing new technologies. The underlying aim of these policies was threefold: *(a)* to reduce costs, and especially staff costs; *(b)* to maximise operational efficiency and asset productivity by detecting and correcting any deficiencies; and *(c)* to improve their market shares by offering new services.

Most of the new technologies introduced into railways and airlines have been based on the latest advances in electronic data processing (EDP). These advances have made it possible to obtain high computing power at low cost and render investment in EDP technology a much more financially attractive option than it was a decade or so ago.

In the following paragraphs we look in turn at some of the areas in which these innovations have been made.

Transport infrastructure and fixed installations

Unlike airlines and road haulage companies, railways have to build and maintain their own tracks and terminals. It is true that airlines are charged landing fees and have to pay for offices and airport terminals. It is also true that trucks and other road users pay either tolls or taxes for motorway construction and maintenance, but they do not carry out the actual construction and maintenance work and are not required to take on staff for that purpose. Furthermore, the railways allege, these charges come nowhere near to matching the true costs of construction and maintenance.

So the railways have a very real incentive to reduce their track-related costs. Advances in steel technology and rail design, the replacement of wooden sleepers by metal or concrete ones, newly designed clamps and continuous welding have resulted in an almost maintenance-free rail whose life-span has increased from roughly 20 to 40 years. The manual and separate tasks of rail welding, sleeper laying, tamping and ballasting have been mechanised and combined into a continuous process. A reballasting machine can advance at a speed of up to 1.6 kilometres per hour; it is manned by two persons and replaces 50 manual workers, which in France means a yearly saving of 7.5 million francs for the French National Railways (SNCF). Finally, computerised recording of track geometry deficiencies and computerised track grinding machines have increased fault detection and maintenance speeds.

Means of transport

Track electrification and the replacement of diesel by electric locomotives have greatly increased speeds and traffic capacity and considerably reduced maintenance costs. Electrification of secondary lines continues to be the main aim in many countries even today.

Advances in traction, bogie and suspension technology have enabled railways to develop extremely fast trains such as the French High-Speed Train (TGV), which requires dedicated tracks, and the ill-starred tilting Advanced Passenger Train of British Rail, which does not. New locomotives with brushless electric motors require less maintenance and fewer revisions than older ones equipped with linear motors. New and lighter passenger and freight wagons (for example, the SNCF's CORAIL or the aluminium-built coal wagon in the United States) also require less tractive energy and less maintenance.[6]

The introduction of the TGV with its twin locomotive cabs at each end yielded several other payoffs. It was no longer necessary *(a)* to couple a locomotive to a stationary train at the platform in order to depart, *(b)* to waste valuable locomotive time waiting for the train's departure in order to recuperate the locomotive which had pulled the train into the station, and, most importantly, *(c)* to use manpower for the unproductive tasks of coupling the new locomotive and shunting the other away to clear the platform for the next incoming train. The result is an almost total elimination of platform shunting railwaymen, who can be used elsewhere, and greater platform and track capacity.

Computer-based robots used in the Union Pacific Railway's rolling-stock maintenance shops in the United States have shown that they can cut costs and improve the quality of work, especially in welding. The pace of introduction has so far been slow owing to the recession and their high initial costs, but the main obstacle to their widespread use, once the economy improves, could well prove to be union opposition. While they may not lead to outright redundancies, they will certainly eliminate the need for new jobs by increasing the output of existing workers.[7]

The most visible and money-saving measures, however, have been those affecting the size of crews. Steam locomotives required two crewmen, and that practice survived the advent of diesel locomotives and even electric ones. The introduction of increasingly sophisticated dead-man devices and radio equipment that allowed direct communication between drivers and the control centres removed the need for a second crewman on security and safety grounds, even on the high-speed trains. In the United States computerised electronic sensors are now replacing the rear-end wagon called the "caboose". In this way, 12,000 expensive wagons which would be due for replacement at a cost of $1,000 million can be phased out, while the guard is moved to the front cab or used elsewhere.[8]

The prime concerns of airlines have focused on fuel savings, reduced maintenance costs and reduced crew costs. Higher speed was already achieved in the late 1950s and early 1960s when the jet engine replaced the piston and turbo engines. Later advances in engine technology produced greater power at much lower fuel consumption (50 per cent less than the early jets) and allowed the development of wide-body jets. Future airframe technology will concentrate on the use of composite materials and laminar flow control to cut down airframe weight and drag (and incidentally reduce the number of rivets and hence the costs of construction and maintenance), while today's jet engines will be replaced by the even more efficient unducted counter-rotating fan engines, which should consume 30 per cent less fuel.

As regards engine maintenance, today's technology makes it possible to monitor total engine performance during the flight and transmit the data at once to the ground-based airline maintenance engineer. It is thus possible to know before the aircraft lands what repairs are needed and to shorten maintenance times to the minimum. This greatly increases aircraft utilisation and productivity rates.

The most substantial savings, however, have been made through the reduction in cockpit crew. Reliable and easily operated radio sets had made the radio operator unnecessary as early as the 1950s, while the development of inertial navigation systems and ground-based very high frequency (VHF) radio navigation systems has enabled airlines to phase out the flight navigator. Future satellite-aided systems will enhance navigation accuracy even more. The advent of reliable wide-body twin-engined jets and the development of video display technology made it possible for the Boeing and Airbus manufacturers to offer airlines the new concept of the two-man Forward Facing Crew Cockpit (FFCC) and thus the possibility of eliminating the flight engineer from medium-range operations – resulting in a reduction of about 30 per cent in cockpit crew costs. In this system all engine malfunctions are recorded by a computer and are then passed on to ground maintenance crews for corrective action. In-flight malfunctions are indicated to the pilots, together with instructions for corrective action, or are corrected automatically and then displayed to the pilots for information. Boeing Aerospace is now developing the two-crew cockpit system for 747 long-range operations as well.

Traffic control

Although trains roll and aircraft fly, the movement of both is controlled from centres equipped with monitoring devices designed to prevent collisions by separating the traffic. The extensive reliance on computers is but the latest phase of a long process.

Trains were first controlled by mechanical switches and points operated from numerous switching and signalling posts along the tracks. Each train driver entering a track section was given a token which he returned on leaving the section. There was only one token and no train could move into a section without receiving it from the switch box. Subsequently the telephone replaced the token system, and was in turn replaced by the electromagnetic and, later, electronic interlocking system, which ensures that an intersection is open in one direction only at any given moment. The elimination of the intricate mechanical relay apparatus meant a substantial reduction in manning and maintenance costs.

Electronics made it possible not only to improve the system of track circuits which pinpoints the location of a train on the track but also to replace the manned signalling boxes with an automatic block signalling apparatus, which is unmanned, resulting in savings of about 70 per cent on signalling manpower. Finally, electronics made it possible to group the many switch boxes along a track segment into one centre, thus yielding substantial additional manpower savings in switching and maintenance personnel. The grouping of three switching posts into one meant that only three persons were needed instead of ten to 15. Future computerised Centralised Traffic Control (CTC) will need only four or five persons to control 500-600 routes and will achieve personnel savings of about 80 to 90 per cent compared with the old manual switch boxes. Already, the entire TGV track from Paris to Lyons, which is about 400 kilometres long, is controlled from a single centre near the terminus in Paris, manned by only 39 persons (of whom 15 are traffic controllers working three eight-hour shifts) instead of the 100 or so who would be needed to man three non-computerised control centres along a conventional track.[9] Without electronics, high-speed trains would not be possible because conventional control and co-ordination techniques would be too slow.

The importance of electronics is evident from Canadian Pacific's investment in 1984 of C$22 million in communications and signalling; this included expansion of the CTC system, installation of microwave communications in mountain regions and fibre-optic cable in the five-mile Connaught Tunnel, microprocessor-based upgrading of signalling at the Winnipeg and Montreal termini and expansion of point-to-point radio communications. Present plans include CTC coverage of 2,500 miles (60 per cent) of main and important secondary tracks and point-to-point radio coverage of nearly 10,000 miles by late 1986. Canadian Pacific is also looking into the possibility of replacing radio entirely by direct computerised data links and visual display units in its locomotives.[10]

Air traffic control has also advanced thanks to EDP. Air corridor and airspace capacity has increased as time-based separation of aircraft relying on pilot position reports has been replaced by distance-based separation using computer-enhanced radar imagery, which is much more precise and allows better use of the airspace. However, this has not resulted in manpower savings, only in increased control capacity. Two controllers were and still are needed per airspace sector or radar scope: one to talk to the pilots, the other to co-ordinate the aircraft's progress with adjacent air traffic control sectors and centres. Air traffic regulation cells in each control centre ensure the overall regulation of traffic volume and adjust traffic demand to the centre's control capacity under different meteorological or technical constraints. These cells are also computerised. Continent-wide traffic regulation has been achieved in the United States by establishing a national computerised traffic regulation cell, which oversees the traffic capacity of 15 major airports. Obviously such a facility greatly enhances the control capacity of the entire system because it affords a view of the global situation and can respond to any changes immediately.

Personnel training

Computer-aided simulation training of pilots and locomotive drivers has yielded enormous savings in fuel and aircraft or locomotive time. It has also improved safety training by allowing the simulation of many contingencies that cannot be demonstrated safely, or at all, in live training. It is also useful for refresher training and proficiency checks.

Airlines have pioneered simulation training because the savings of millions of dollars in fuel and increases in aircraft productivity justified the acquisition of simulators even though these were very expensive. The latest computer-aided simulators are capable of providing such near-perfect and realistic imagery that the United States Federal Aviation Administration (FAA) has authorised the certification of simulator-trained pilots to fly without any further training on real aircraft.

It is only during the past three years or so that railways have found it worth while to introduce computer-aided simulators for training locomotive drivers. This is because the considerable computing power required to run a simulator had not previously been available cheaply. Several railways in the United States have already stated their satisfaction with simulators since they shorten training time and yield considerable savings in fuel and locomotive time.[11]

Personnel administration

In a further effort to cut costs, many airlines and railways have computerised their personnel administration systems. Reduced paperwork and the elimination of many boring and repetitive tasks were the immediate payoffs. The SNCF system has two main features. The first is a computerised personnel file built up from about 600 standardised occurrences that are likely to happen in a railwayman's career. The second is the grouping of the formerly separate administrative tasks relating to an event or a case. Each personnel officer now deals with a complete case from start to finish: this gives a greater sense of purpose to what previously was a myriad of seemingly disconnected and directionless actions. Computerisation of personnel administration also resulted in the elimination of about 120 jobs, or a saving of 18 million French francs a year. Another unexpected payoff was an 80 per cent reduction in paperwork for top-level managers since they now had direct access to the data they needed.[12]

Crew scheduling

Computerisation of aircraft and crew scheduling has become a regular feature in about 60 per cent of airlines in the United States, and has yielded significant productivity advantages. However, a new application of EDP to rescheduling problems following disruptions of all kinds has even greater promise, in that it enables airline planners to re-establish their schedules within minutes, taking account of work rules, duty time limitations and other constraints, and thereby achieve an optimal use of aircraft and crews. TWA had to cancel 300 flights over three days in 1982-83 when a massive snowstorm hit the United States: many of these cancellations were caused by the sheer human inability to reshuffle the scattered aircraft and crews in time. With the new rescheduling system such a breakdown is not likely to happen again. In a simulated cancellation of 70 flights, the new procedure (called Operational Control System) re-established a schedule within eight minutes.[13]

Marketing and sales strategies

Competition from trucks has caused the railways to lose a large share of wagon-load freight traffic, while competition from buses and coaches has resulted in considerable, but perhaps not as heavy, losses of passenger traffic over short and medium distances, especially in the United Kingdom and the United States.

As regards freight, British Rail decided to abandon the wagon-load business altogether and concentrate on unit-train loads where trucks have no chance of competing with trains. Consequently it is gradually closing down its marshalling yards. The SNCF, however, decided to remain in the wagon-load business and fight back by improving its services in order to attract new customers. As early as 1978 it introduced a centralised computer system for controlling freight traffic (known in France as GCTM). The GCTM's main central computer is fed with dispatch and arrival reports from the various freight terminals and marshalling yards, and issues instructions accordingly. This has resulted in a saving of 500 marshalling-yard workers and telex operators.[14] A further improvement is in the offing, with a decentralised system called ETNA, in which 50 computers will cover the whole of France. The computers will be linked up among themselves and all will be connected to a main computerised data base. The workers themselves will feed data into these computers by keying the wagon codes into portable terminals in the marshalling yards. This will require only two workers instead of the three needed hitherto. It will also enable freight managers to monitor the progress of each wagon, not only each train, and when combined with a system of guaranteed delivery in 24, 48 or more hours, it will increase throughput capacity and speed up delivery times. Finally, ETNA will allow the SNCF to trim up to 850 jobs in the invoicing departments, the marshalling yards and the border crossing points. This means that the 330 million French francs it costs will be recovered in about two years. It is expected to become operational at the end of 1987.[15]

Manufacturers in the United States are already developing transponder devices for automatic wagon identification and tracking. Like aircraft transponders, they will beam the wagon code number to electronic interrogators fixed at selected switching points, which in turn will feed the information directly into the nearest computer terminal, thus saving even more manpower and providing real-time data to managers.

The SNCF has also undertaken an extensive marketing operation to boost passenger traffic and reduce costs. The TGV promotion campaign has resulted in an 85 per cent occupancy rate, mainly thanks to the computerised compulsory advance reservation system which enables the SNCF to adapt capacity to demand very precisely and avoid the wasteful surpluses and inconvenient shortages of seating space that are frequent on the normal lines. Finely tuned scheduling of TGVs with the help of computers has enabled the SNCF to compete successfully with air transport on the Paris-Lyons-Geneva routes. The SNCF estimates that 20 per cent of TGV passengers are former air travellers.[15]

In its marketing efforts the SNCF also distinguishes between commuting and main-line traffic. It has extensively automated ticket sales for commuters, putting speed and efficiency above personal service; at the same time, while keeping the personal service for long-distance passengers, it has also introduced computerised ticket-issuing machines at the main-line counters so as to collect almost real-time data on the nature and volume of this traffic. This computerisation has eliminated a lot of paperwork and post-sale tasks which hitherto took up about 30 minutes per employee shift. The ultimate aim is to eliminate payment by cash or cheque (which currently may take up to nine minutes per ticket sale) through the introduction of prepaid magnetic cards, memory bank cards or the "minitel" system.

In their quest for new market outlets, both airlines and railways have turned to travel agencies and have either installed the hardware or simply sold them the software for computerised seat reservations. Travel agent commissions vary between 5 and 15 per cent, but the sales generated have justified the move. More than 30 per cent of the SNCF's ticket sales originate from travel agencies, and for airlines this figure would be much higher, around 80 per cent for scheduled services and 100 per cent for charter flights. Thus travel agencies now constitute a new sales outlet at little or no additional expense to the railways and airlines. In fact, this shift has enabled many airlines to increase their sales without having to increase their ticketing and sales staff and so keep only the minimal number of offices open for representation purposes.

The limits of automation

Job computerisation usually substitutes push-button and keyboard manipulation for a series of manual operations. This is true of air traffic control, where video displays have replaced the handwritten flight progress strips; it is true of aircraft, where all operations – including the delicate ones of aborted take-offs and landings – are fully automated at the push of a button; and it is true of rail traffic control, where luminous displays and buttons have replaced the old-fashioned signal boxes and mechanical switch levers. Computers can even replace the driver of an underground train.

As a rule, however, the computer is not error tolerant, which means that the employee must respect a prescribed order of operations and adapt his working methods to computerised procedures. With time and habit the worker loses his manual skills, which could have serious safety implications in the event of a computer malfunction, requiring the worker to assume immediate manual control.

So, how far should jobs be automated? Three approaches dominate today's man/machine work distribution: *(a)* to provide computers etc. only as decision-making and advisory aids and leave the actual job to the pilot, driver or traffic controller; *(b)* to automate the job further by telling the computer to take decisions, but leave the driver to supervise the computer and override it if needed; *(c)* to automate the job completely and phase out human decisions altogether.

Because the first two approaches require rather complex man/machine dialogue, the last seemingly offers the best solution for guided systems such as railways and metros.[16] It is rather paradoxical, therefore, that drivers in the computerised Paris metro have to spend two hours or so a day on manual driving to retain their manual skills in case they have to take over from the computer, while in a hypothetical automated ATC system air traffic controllers would have to train on simulators in order to be able to do so too. This necessity offsets some of the manpower savings that otherwise would have been possible.

An example of the fully automated approach is the unmanned metro called VAL which has been operating in Lille for more than two years without any incident or accident; future metro technology certainly points in that direction, as shown by the decision of Toulouse to choose VAL for its new metro network. VAL staff costs in Lille account for only 37.6 per cent of total operating costs, well below the 53 per cent of the Tyne and Wear Heavy Rail system in the United Kingdom, or the 76 per cent of the Calgary Light Rail network. Revenue from fares covered 80 per cent of current operating costs in 1984 and this proportion was expected to climb to 94 per cent in 1985.[17]

III. Implications for the workforce and industrial relations

Basic attitudes towards new technologies

The initial employee attitude may be described as one of suspicion and apprehension: suspicion about the real aims behind the introduction of new technologies and apprehension about job security, retraining difficulties, especially for older workers, and future careers. These fears and doubts stem from what can be described as a basic human resistance to any change in proven routine and procedures. This is particularly true in air traffic control and flying operations where many safety precautions and procedures are based on routine drills and tasks, and where the introduction of changes requires not only that employees learn the new tasks but also, and this is much more difficult, that they forget the old drills and shed long-established reflexes and habits. The initial refusal and rejection are usually followed by a period of adjustment and later by heavy dependence on computerised technology, to such an extent that employees may be unable to work without it if it breaks down. The outcry raised by the pilots' unions when the FFCC was being contemplated is just one example. Although in public the pilots' reaction was to reject what in their eyes was unproven, unsafe technology, in

Table 2. IATA members' employees, 1979-83

Employees (at end of calendar year)[1]	1979	Change (%)	1980	Change (%)	1981	Change (%)	1982	Change (%)	1983[2]	Change (%)
Pilots and co-pilots	48 077	8.4	47 656	−1.9	48 156	0.1	46 537	−4.6	45 899	−1.6
Other cockpit personnel	14 989	−2.9	16 185	6.9	14 444	−10.6	13 992	−4.2	14 047	0.9
Cabin attendants	101 653	7.6	102 840	0.7	103 327	−0.3	105 361	0.9	107 096	1.6
Maintenance and overhaul personnel	195 048	5.7	193 362	−1.5	195 469	0.6	189 773	−4.2	184 897	−2.4
Ticketing and sales personnel	128 941	4.8	128 371	−1.3	129 952	0.4	119 412	−9.5	118 446	1.6
Traffic-handling personnel	171 775	2.8	171 566	−1.1	172 927	0.3	166 838	−4.5	168 968	1.8
All other personnel	229 275	3.1	244 174	4.7	233 783	−3.8	241 140	1.2	236 427	−3.5
Total	**889 758**	**4.5**	**904 154**	**0.6**	**898 058**	**−1.0**	**883 053**	**−3.0**	**875 780**	**−0.8**

[1] Annual totals include estimates for those members which did not report and for individual items not submitted. Percentage changes shown have been adjusted to eliminate the misleading effect of IATA membership changes (104 in 1979, 107 in 1980, 114 in 1981, 123 in 1982, 125 in 1983). The growth statistics quoted therefore refer to the performance of airlines that were members in both of the compared years; for statistical purposes, Pan Am is considered an IATA member throughout the time-series. [2] Preliminary.

Source: IATA.

private they were more willing to admit that, provided it worked and was fail-safe, the FFCC was a positive development that would diminish cockpit workload.

Loss of jobs continues, however, to be the main cause of trade union resistance to new technologies. Trade union leaders tend to view unreplaced posts as a loss of potential membership and they may therefore oppose labour-saving innovations more fiercely than their members, especially if the latter's opposition is muted by an enterprise policy that precludes lay-offs.

Impact on employment

New technologies have altered both the volume and the structure of employment in air and rail transport. Table 2 shows employment trends in IATA airlines from 1979 to 1983. Thus the drops of 10.6 per cent and 4.2 per cent in the number of "other cockpit personnel" (i.e. flight engineers) in 1981 and 1982 were largely due to the impact of the FFCC and its two-man crew, while the 9.5 per cent drop in ticketing and sales personnel in 1982 may be attributed to the shift of ticket sales from airlines to travel agents. These and other economies resulting from technological innovations largely explain why the number of employees did not increase commensurately with the rise in available capacity (see figure).

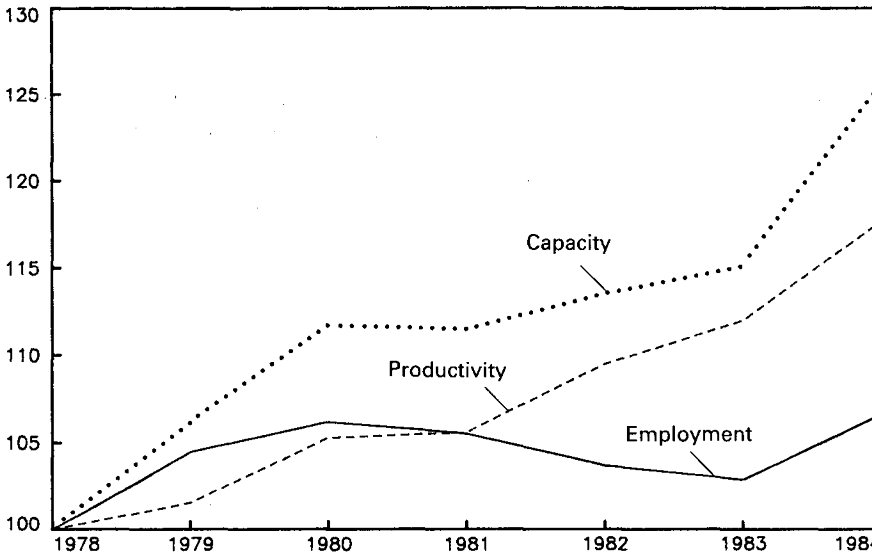
Table 3 shows that in 1975 the SNCF employed 24,560 semi-skilled workers and 37,060 unskilled workers. By 1982 their numbers had dropped to 14,806 and 17,263. On the other hand, the number of technicians rose from 20,547 to 22,399. It is obvious that new jobs are created in some occupational categories but they are few in number, hence the overall savings.

Equally obvious is the fact that attitudes to technological innovations will be affected by the general employment situation, the employment repercussions of particular innovations, and the personnel policy of the employer. The SNCF's policy is one of guaranteed employment for its established employees and most of its manpower savings come from the non-replacement of some of the 12,000 to 13,000 employees who retire each year. In this way, management has not been faced with stiff opposition from railwaymen, who are secure in their jobs and know that they will not be thrown out. Other railways, such as British Rail, have had to resort to early retirement or outright redundancies, which have met with more resistance and have also been more expensive.

Impact on industrial relations

There is strong evidence that the basic premises of industrial relations in air and rail transport have been irrevocably changed in some countries, and certainly in the United States, by two main factors: deregulation of the two industries, and the growing financial vulnerability of some airlines and

Capacity, employment and productivity of IATA airlines (all services), 1978-84 (1978=100)



Note: Capacity = available tonne-km (ATK); employment = number of employees at end of calendar year; productivity = ATK per employee.

Sources: *World Air Transport Statistics 1983* and *Annual Reports* for 1984 and 1985 (Montreal, IATA).

railways, which makes them particularly sensitive to government pressure.[18] Labour-related costs and productivity have thus become a vital factor in the competitiveness of the enterprise, and many unions, especially those likely to be the most hurt by lay-offs, have agreed to a variety of concessions of which the most important relate to schedules, work rules and pay.

In general terms, computerisation and automation have serious implications for the bargaining power of labour, including the use of strike action, in rail and air transport.

It is true that with computerisation more and more operations are concentrated in the hands of fewer and fewer operators, thereby increasing the leverage they can exert. But the same technology enables management itself either to man the control centre and maintain operations even during a strike, possibly at a reduced level, or to construct another computer peripheral or terminal elsewhere and control operations from another location in the event of the main control centres being occupied.

Another powerful consideration is the versatility of EDP-related technologies. Today's state of the art makes it possible to take a facility or an EDP technology initially created for technical purposes and to use it for collective bargaining and other industrial relations purposes. This happened in the air traffic control system in the United States, when on 3 August 1981

Table 3. SNCF employment (permanent and auxiliary) by occupational category, 1965-82

Category	1965	1970	1975	1980	1981	1982
Engineers	7 830	8 092	8 117	8 790	8 869	8 998
Top management	1 630	1 682	3 629	3 966	3 935	3 999
Technicians	23 408	22 393	20 547	21 288	21 413	22 399
Middle management	8 250	8 588	10 002	9 924	9 731	9 722
Qualified office workers and young trainees	77 104	69 581	64 307	58 844	54 746	56 771
Foremen	10 694	9 065	13 970	10 677	10 434	10 799
Skilled workers	101 555	84 307	92 646	101 859	105 079	106 772
Semi-skilled workers	71 831	61 266	24 560	15 496	15 302	14 806
Unskilled workers	50 929	35 471	37 060	19 572	17 809	17 263
Training staff, police, etc.	2 088	1 621	1 989	1 659	1 702	1 809
Total	**355 319**	**302 066**	**276 827**	**252 075**	**249 020**	**253 338**

Source: SNCF.

11,400 air traffic controllers went on strike. Their union leaders expected the system to collapse within days. Instead the strikers were sacked and although traffic levels were cut by 25 per cent, the system survived and the strike failed. The sacked controllers were not rehired.

The national air traffic flow-control computer proved a key element in helping the Federal Aviation Administration (FAA) to cope with the aftermath of the walkout. The computer is able to extrapolate capacity levels for the country's 15 major airports, and in the event of large-scale weather disruptions, such as typhoons or snowstorms, it is able to allocate alternative traffic routes and airports to bypass the "contaminated" areas and ensure air traffic flow. Some delay is inevitable, but the computer is able to keep it to a minimum.

Using this computer to simulate the effect of a strike rather than that of bad weather, the FAA had prepared two national contingency anti-strike plans, which it was able to put into effect. It would be no exaggeration to say that, without this computer, the outcome of the strike would have been radically different.[19]

TWA's rescheduling system, mentioned previously, is just as versatile and could be used for collective bargaining purposes, especially for analysing the economic impact of trade union work-rule and wage demands, as pointed out by one of its managers. There can be little doubt that the system could also help TWA's management to cope with a pilot walkout just as effectively as it does with bad weather.

Several railway trade unions have signed collective agreements relating to the choice, introduction, application and impact of new technologies. Generally speaking, they try to secure provisions specifying, inter alia, that *(a)* the management must inform the union of any proposed changes at the earliest possible moment, and discuss with it the probable consequences of such changes; *(b)* any redeployment of workers must be voluntary and any retraining at the employer's expense; *(c)* employees redeployed in lower-paid jobs must retain their previous wage rate; *(d)* special early retirement facilities must be granted to any redundant employees. Agreements including such provisions may reduce or dispel the employees' initial distrust of technological innovation.

The introduction of new technologies does not seem to have been a major issue in airline collective bargaining. One must remember that airlines have pioneered technological innovation since their inception, and that technological change tends to be viewed as an ongoing and natural process. One notable exception is the FFCC, which implies not merely redundancies but the elimination of an entire occupational category, that of the flight engineer. As we saw earlier, some rumblings of discontent made themselves heard at the time the FFCC was introduced – and Air France still flies its Airbuses with three-man cockpit crews – but by now most pilot unions have accepted it.

IV. Some tentative conclusions

The trend towards the automation and computerisation of jobs in rail and air transport is clearly established and will have to be intensified unless the economic and budgetary constraints facing the railways and airlines are relaxed.

Unless traffic rises, new technologies will create fewer jobs than the number they eliminate and overall employment levels will decline. The structure of the workforce will change too, with the phasing out of unskilled jobs and the higher skill requirements of those newly created. The number of simple, undemanding jobs now available for workers no longer physically fit to occupy their previous posts will drop and it will become harder to re-employ those workers within the enterprise. Further personnel reductions in hitherto fairly "protected" occupations can also be expected.

Today's computers make it a lot easier for management to monitor employee work performance and productivity, but excessive use of such facilities can easily demoralise personnel and damage labour-management relations.

The advent of artificial intelligence will probably mean that computers will encroach upon hitherto untouched areas such as decision-making in air traffic control and train driving in surface railways.

Last but not least, there are growing signs that computers that were introduced for technical purposes may be used increasingly in the industrial relations and collective bargaining sphere. This could be the biggest challenge facing management and labour in the future. And the future is already here.

Notes

[1] Commission of the European Communities: *Europa transport: Analysis and forecasts 1983* (Luxembourg, 1983), pp. 11-13.

[2] L. S. Miller: "Fuel: Still running scared", in *Railway Age* (New York), Oct. 1985, p. 6.

[3] International Air Transport Association (IATA): *The state of the air transport industry*, Annual report (Montreal, 1979), p. 5; and idem: *Annual Report 1985*, p. 4.

[4] D. K. Henderson: "World airline labor bill has doubled since 1975", in *Air Transport World* (Stamford, Connecticut), Dec. 1981, pp. 61-64.

[5] Under Chapter 11 a bankrupt company may file for court protection from creditors so that it can reorganise its operations in order to recover its viability and pay off its debts. These provisions are tantamount to giving a bankrupt company a final chance to survive. Continental filed for protection before it actually became bankrupt. See "Continental Air tries a daring way to solve labor ills: Bankruptcy" and "Some Continental Airlines employees fly in the face of opposition from strikers", in *Wall Street Journal* (New York), 29 Sep. 1983 and 13 Oct. 1983.

[6] See, for example, SNCF: *Rapport d'activité 1983* (Paris, 1984), the chart (p. 40) showing the increase in the number of electric locomotives, and the chart (p. 45) showing the decrease in the number of general revisions needed.

[7] F. Malone: "Here come the robots", in *Railway Age*, June 1984, pp. 40-42.

[8] L. S. Miller: "Cabooses: The beginning of the end", and F. Malone: "Cabooses: The end is in sight", ibid., Feb. 1985, pp. 6 and 27-33.

[9] SNCF: *Le poste de commandement de la ligne à grande vitesse* (Paris, 1984).

[10] F. Malone: "CP: Signalling for greater capacity", in *Railway Age*, June 1984, pp. 54-56.

[11] "RALES: The multi-purpose locomotive simulator", ibid., Apr. 1983, p. 29.

[12] Information supplied to the author by SNCF officials.

[13] "New crew rescheduling system copes with flight disruptions at TWA", in *Air Transport World*, Nov. 1985, pp. 71-78.

[14] SNCF: *La gestion centralisée du trafic marchandises* (Paris, 1983), p. 19.

[15] SNCF information.

[16] The trouble with mixed man/machine systems is that the situation resulting from a possible computer breakdown may be so complex that it is beyond the powers of calculation and reflexes of human operators to resolve.

[17] "VAL in Lille: Already over two years of success", in *Railway Age*, Oct. 1985, advertisement. If a VAL train breaks down between two stations, the following train is brought up slowly and coupled with it; the rear train then pushes it to the next station. If this cannot be done, the passengers are instructed by the intercom system to leave the train and walk to the next station on the special walkway beside the tracks. "Unmanned metro opened in France", in *Locomotive Journal* (London), July-Aug. 1983, p. 12.

[18] For a fuller discussion of these changes see D. A. Arouca: "Railroad collective bargaining – Anatomy or pathology?", and P. Cappelli and T. A. Harris: "The changing system of airline industrial relations", in Industrial Relations Research Association: *Proceedings of the Thirty-Seventh Annual Meeting, December 28-30, 1984, Dallas* (Madison, Wisconsin, 1985).

[19] "Flow-control facility helps cope with strike", in *Aviation Week and Space Technology* (New York), 9 Nov. 1981, p. 195.