

**16.781 Airport Systems Planning, Design and
Management**

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Term Paper

Paris – Charles de Gaulle Airport

**A critique of the development of France's first
airport**

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Thursday, December 9th, 2004.

Introduction

Being a French citizen, Charles-de-Gaulle airport is my gateway to reach Boston and MIT. Since I am living in Strasbourg, I use this airport as a connecting passenger. I am therefore often experiencing the ups and downs offered by France's main airport.

In this report, my intent is to present a critique of one of Europe's youngest platform through a historical perspective. This work aims at showing some of the main design and engineering decisions that were made in the development of one of the largest airfields outside the United States.

In this purpose, I will first review the origins of CDG. I will then focus on the different terminals constituting the airport today. Finally, I will examine the different communication means linking CDG to Paris and the rest of France, as well as those linking the different terminals together.

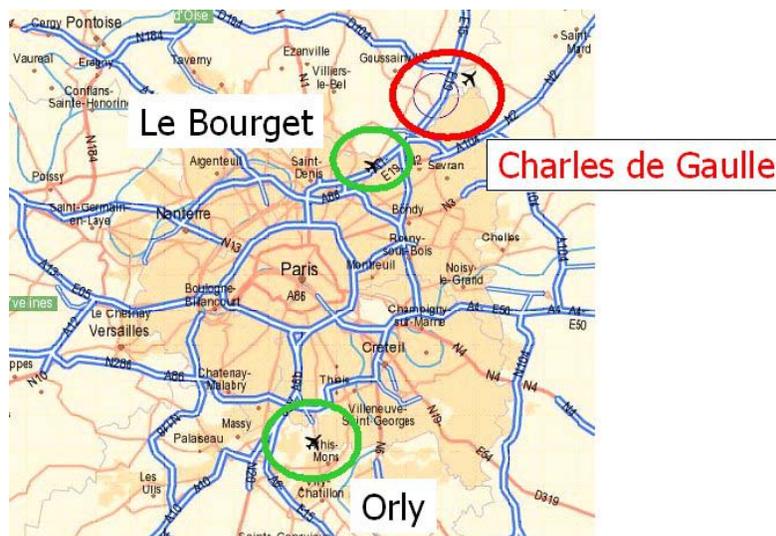
1 Origins of Charles-de-Gaulle airport

In the early 1960's, Paris had two main airports handling international and domestic traffic: Le Bourget and Orly. Le Bourget airport is Paris's historical airfield. It opened on October 9, 1914, in the North of Paris, as a military airfield aimed at protecting the French capital as the war against Germany was roaring. It opened to civil aviation in 1919, and was associated to many aviation events such as Lindbergh's first non-stop flight eastward across the Atlantic in 1927. In 1937, a brand new air terminal was opened, making this airfield Paris's international air gateway. But the facilities there quickly became saturated after the end of World War II; provisions were then made to operate the airfield of Orly, located 25 km South of Paris. This military airfield which was controlled and rebuilt by the US Air Force in 1944 – 1945, received a wooden air terminal in 1948. A newer and bigger facility was then opened in 1954. This terminal was finally extensively modified and extended, and persists today as Orly's South Terminal. This facility was designed to accommodate 6 million passengers a year, a threshold that was reached in 1966.

Aware of this upcoming saturation in capacity at Orly and the already existing saturation at Le Bourget (with more than 2 million passengers a year), the French government decided in 1964 to build a new airport for the capital. Forecasting an always higher traffic rate, this airport had to eventually be able to handle 45 million passengers a year, by 1985. As Jacques Block, Director of Planning and Development for the Paris Airport Authority (ADP, an autonomous government owned authority created in 1945, in charge of operating the airfields in a 35-mile circle around Paris) points out in his book "Airports and Environment", this airport had to be placed in a very low populated area, to avoid complaints linked to noise disturbances to the neighbouring population, and in an area close enough to the city of Paris, to allow a convenient and cheap accessibility to all the facilities.

The region of Roissy-en-France seemed to be a perfect match. Located 30 km North from Paris, it was at the time a very low populated area covered with fields and dedicated to extensive agriculture. A ground surface area of 7,500 acres, nearly one third of the land area of the city of Paris was allocated to the site of the airport. The main requirements for airport sites and their accesses consisted already at that time in having surface areas of the order of some thousands of acres to accommodate the runways, taxiways, aprons, terminals, hangars but also the access roads and parking lots. In 1971, as the first part of Paris Nord airport was being built, the Paris Airport Authority estimated to 250 acres the area needed to "contain the equipment and facilities required for handling each batch of one million passengers or two hundred million pounds of freight per year", which explains the wide provisions made from the very beginning. In the meantime, noise already counted among the highest operational constraints for an airport. Low populated sites are less likely to raise conflicts from neighbouring cities and render extension possible. Finally, locating the airport site as close as possible to the city area is the best way of cutting down on connection times for O/D passengers and avoiding outrageous expenses in high speed rail systems. Also, beyond these technical considerations, the point of view of the Paris Airport Authority at the time was that the Paris urban area, strong of 10 million people, could be viewed as

two sub-cities of 5 million inhabitants each, separated by the Seine River. In that extent, each sub-city could be equipped with an international airport; Orly already stood as the airport for the southern half. The new platform would become the airport for the northern one. In the minds of ADP planners, Orly and Paris Nord were to be operated independently in terms of airline operations. Both airports would be susceptible to offer flights to the same destinations. This vision obviously proved to be wrong.



Source: www.mappy.fr

It is in this context that the construction of the airport started, on December 1st, 1966.

Beyond the necessity to satisfy an ever growing demand rate, France decision makers wanted to make sure this airport would reflect the French knowledge and savoir-faire in terms of civil and aeronautical engineering. This policy was in the direct continuity of the "grandeur" policy implemented by President Charles de Gaulle during his mandates. The design and inauguration of Orly's South terminal in 1961 already reflected that trend. The responsibility for the design was given to Aéroport de Paris' chief architect Paul Andreu. Originally named Paris Nord, the airport was renamed after President Charles de Gaulle in 1974 as a tribute to his action and as a symbol of the "esprit de Grandeur" he embodied.

2 The different Terminal Buildings

2.1 Terminal 1

Charles-de-Gaulle's first terminal was inaugurated on March 8th, 1974. It was mainly operated by Air France and UTA but it welcomed also international carriers such as TWA. This terminal was presented as the most modern airport facility at the time in terms of design and operations. Jacques Block's book entitled "Airports and Environment", as well as his presentation to the Royal Aeronautical Society regarding "International Airport Planning as influenced by Aircraft Development", explains the logic laying behind the choices made for terminal 1 at CDG (These publications are dated respectively from 1971 and 1968). Two of the main constraints airports were about to face at that time were the need for runways, taxiways and aprons able to handle larger sizes of aircraft, and the ability to increase the size of parking lots as part of the growth in passenger traffic rates. The design for CDG was then based on an answer to the critics that could be formulated against the already existing passenger terminal shapes around the world, but essentially in North America, that aimed at tackling these aforementioned concerns. Here are these various design concepts and the arguments ADP put forward against them:

- ✘ The concept of "Plane-less" terminal adopted at Washington Dulles, where planes are parked at a distance from the terminal and where passengers are processed to and from the planes by vehicles, seemed interesting as it eliminated the problem of having to adapt the organization and the facilities inside the terminal to the aircraft size, as the latter might evolve further. But such a design can cause significant wastes of time as it cannot allow continuous loading and unloading of the aircraft the way jet ways can. Such a constraint applies even more strongly to large aircraft, even in spite of high capacity buses such as "transporters".

- ✘ The concept of “finger” pier was also criticized. Already in place at Orly South at the time, ADP wanted to design a terminal where the walking distance for any passenger between their car’s door and the plane’s gate would be minimal or at least remain within acceptable limits, which finger piers haven’t been able to provide for the flights parked at their tips.
- ✘ Although it does not solve the problem of curbing walking distances and does not allow a greater number of planes to be accommodated in a given amount of space, the concept of satellite buildings, as implemented in Newark, was perceived a bit more positively in the sense that the walking distances are made almost equal for everyone.
- ✘ The linear concept was also rejected. This concept seemed interesting to reduce the walking distances for passengers by multiplying check-in counter areas and security check points. Passengers would park their car as close as possible to the entrance gate of the terminal behind which they would immediately find the check-in counters for their flight. The corresponding boarding gate would be located in the immediate vicinity of these facilities. But this concept would be efficient only for departing passengers as the likelihood for their return flight to park at the exact same gate where they left their car is slim. Connecting passengers would also have to walk long distances to reach their next flight. Finally, the cost of multiplying passenger processing facilities is prohibitive. An improved version was the circular terminal, such as the ones of DFW, with the parking lot occupying the inner part of the half circle shape terminal. All passengers using this terminal are more likely to walk the same distance between their cars and the entrance gates corresponding to their flights.

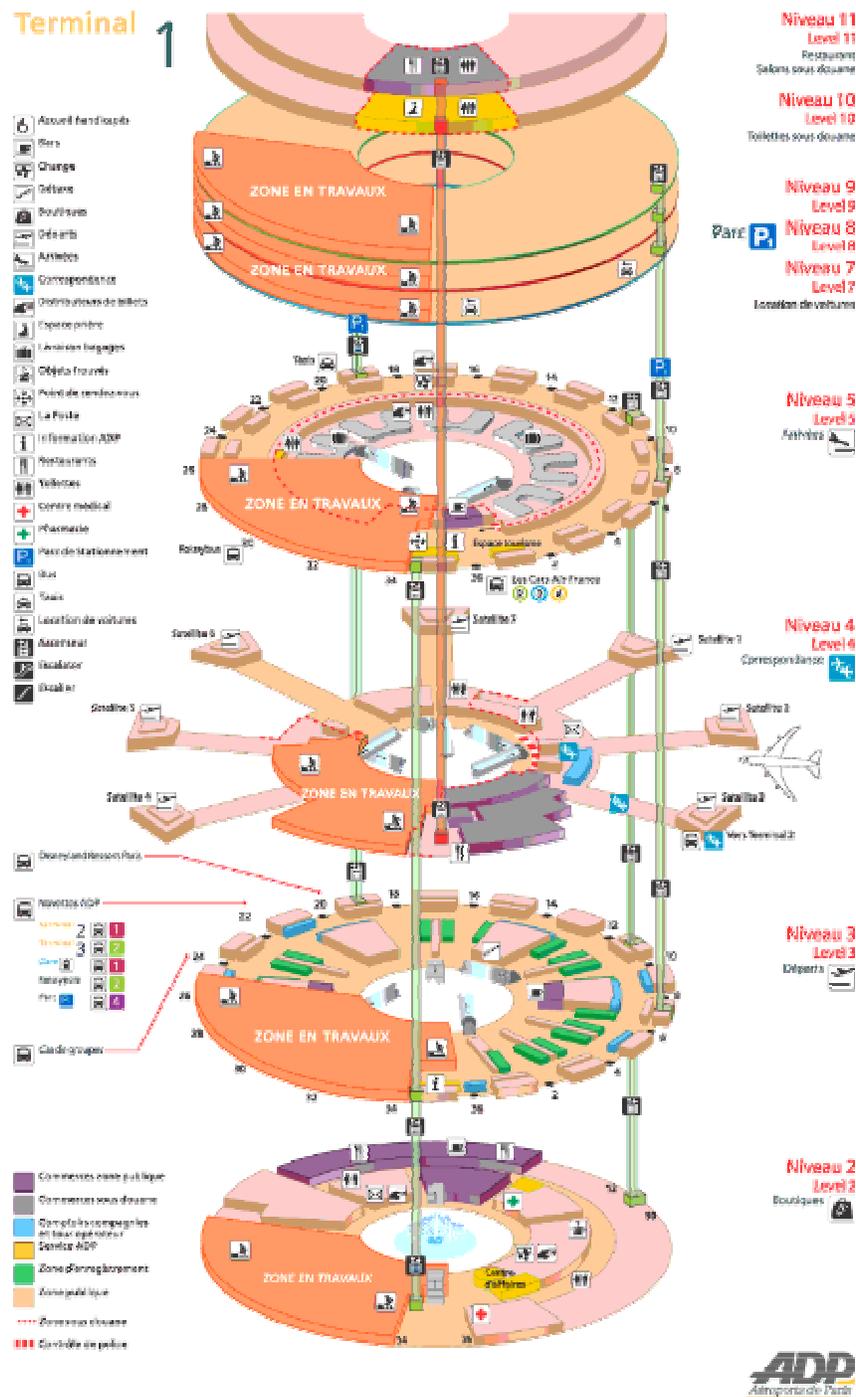
From there on, ADP came up with a design that was trying to combine the various advantages of these previous concepts. In order to provide shorter and equal walking distances for all passengers, ADP opted for a circular building gathering the different check-in, security and custom facilities, as well as parking lots on the roof. Airplanes then park around 7 satellites, remotely and equally located around the main central

building. These satellites are surrounded on all sides by planes, so as to maximize the number of aircraft benefiting from a jet way access to the terminal. Airplanes theoretically park around a satellite in such a manner to be able to leave the gate without any ground system help. Each satellite is connected by hall ways and automatic passage ways to the main building. All this allows a continuous through flow for boarding and de-boarding passengers. The costs of the linear concept are avoided while connecting times are improved.

Here is a picture of this concrete made terminal designed by the architect Paul Andreu. It was meant to reflect the French "savoir-faire" in civil and aeronautical engineering:



Each of the seven satellites is divided into 4 smaller waiting rooms giving access to two jet ways. As for the central building, which has the size of the Coliseum of Rome, here is its current organization:



Source: www.adp.fr

The central building is composed of 3 main levels, which are designated as levels 3, 4 and 5. Unlike conventional terminals, the arrival level is located at a higher level than the departure one. These two areas are separated by a transfer level where passengers get access to the hall ways leading to each of the 7 satellites. This organization allows arriving, departing and connecting passengers to meet only on the connecting level, where they are not in possession of their luggage, which improves the flow capacity in this area. In the meantime, each underground passage leading to a satellite is divided into two contiguous hall ways separating the flows to and from that satellite. To change levels, passengers will use moving walk ways located in the central open area. These tubes have stood as the main architectural feature of Terminal 1:



Source: www.paul-andreu.com

I could not find a justification for putting the departure level below the arrival level as these two configurations require both a special baggage handling system and access road belts. However, I suppose the location of the shop level may have played a role. Departing passengers are the main customers of airport shops. This level did not require any direct access gate from the road system surrounding Terminal 1. In order to optimize the organization of the road system around the terminal, the shop level may have been put in the lowest level accessible to the public, which called for the departure level to be put immediately on top of it.

Despite its very promising organization and a design that is still considered very audacious from an architectural point of view, Charles de Gaulle's Terminal 1 proved to have numerous flaws.

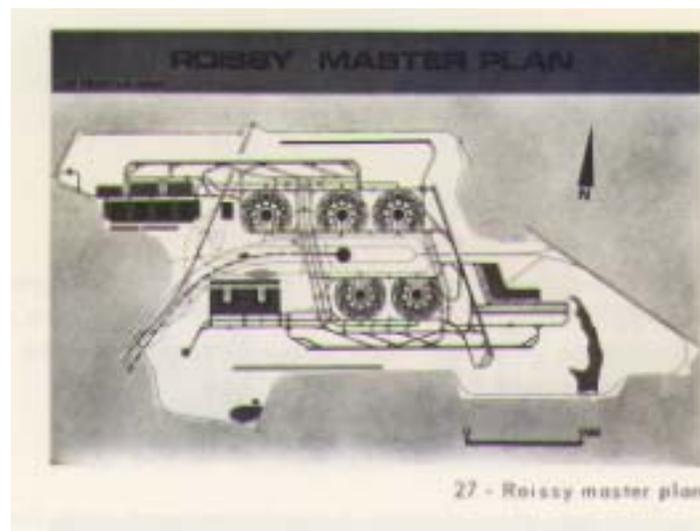
- ✘ The design of the terminal does not allow to perform any extension. The road belts surrounding the different levels are the main factor for that situation. Expanding the departure and the arrival areas can only be achieved by splitting them over several levels, towards the parking lot for the latter, towards the shopping level for the former. The transit level, which gives access to the satellites and lies between the two other areas, defines a clear barrier for any other expansion possibility. As for the satellites, they can only be extended by reducing the outer aprons and taxiway belts surrounding the whole terminal. This architectural solution hence did not allow any flexibility for extensions at all.
- ✘ When this terminal was designed, one of ADP's concerns was to keep the walking distances for passengers as short as possible. The finger pier concept was criticized for its inefficiency in that respect. But this design did not actually prove to be efficient either. If we consider the case of a passenger that has parked their car on top of the terminal, they have to travel down between 3 and 5 floors. They then have to walk in the departure level to find their check-in counter. Although these counters are numbered, there is no clear indication to passengers for the shortest way to reach them. Once check-in is done, our passenger must reach the transfer level by using one of the three transparent tubes available. Once there, they must tour the transfer level to reach the access way to the correct satellite. Finally, the walking distance from the central building to the satellite is not negligible. Provided the passenger engages on a moving walkway, there is no possibility for them to return to the main building before reaching the satellite, as the moving walk way consists of one single section joining the two ends of the connecting corridor. The overall walking distance hence turns out to be not negligible at all, not to mention the fact that passengers are constantly

being disoriented and deceived by the circularity of the terminal and the fact that the different levels do not connect in an obvious way.

- ✘ In their search for an ingenious baggage handling system, the Paris Airport Authority installed a very innovative system that actually proved to have poor efficiency. Baggages are handled in the underground of the central building. They must then be processed to the baggage claim level. A conveying system called the Diplodocus consisting of two large rubber strips compressing the bags was installed. But luggages were then affected to the wrong carousel. 1% of them did not make it to the right place.

Terminal 1 was originally designed to handle 7 to 8 million passengers a year. According to ADP, it handled 9.3 million passengers in 2003, which corresponds to a little less than 20% of Charles de Gaulle entire traffic.

In 1971, the French authorities were expecting a sharp increase in air traffic for the coming years. They expected this terminal to be already congested by 1976, with 11 million passengers. To handle this growth, ADP planned on opening 5 identical terminals by 1985, when the saturation point would be reached with 45 million passengers, as shown on the following picture.



Since April 2004, Terminal 1 is undergoing renovation works. This project is divided into 4 main steps, each dedicated to a quarter of the building. In 2006, the new renovated terminal should still feature the same organization in terms of level, with the noticeable exception of the shopping and transfer levels. The former will accommodate the end-station of the upcoming VAL, linking the different terminals together, as we will see later on. It should also be provisioned with check-in counters on half of its floor area, while the other half will still accommodate shops and restaurants. The transfer level will also be fitted with shops. This move will allow shops to enjoy a better visibility from the part of both departing and arriving passengers, as was not the case in the current organization.

Air France was originally the main user of this terminal and it is still the only airline operating the airport as a connecting hub. Now that the French carrier has moved to terminal 2, only airlines serving CDG as an O/D airport are using CDG1. The potential of this facility for connecting passengers remains thus unused.

2.2 Terminal 2

The construction plan described in the "Air Transport" report of the Comity for the 6th economic plan and which scheduled an opening of the second terminal, identical to the first one, for 1976 turned out to be too optimistic. The construction work for Terminal 2 started in September of 1977.

Aware of the different limits encountered in the operation of the first building, ADP and its chief architect Paul Andreu decided to design and build a terminal of a different type, gathering features in strong opposition to the previous ones implemented.



Aéroport de Paris decided to opt for a linear design for Terminal 2. The new terminal would be formed of smaller entities aligned on both sides of a spine road. These smaller sections would be built progressively at a pace determined by the forecast in air traffic growth. The non-expandable circular model of Terminal 1 was hence abandoned for a design layout that would allow a much larger degree of flexibility. ADP along with the

support of the French government decided to continue developing Charles de Gaulle as a show case of the French civil engineering and architectural know-how. Paul Andreu's vision consisted there in having arched concrete and glass buildings forming a succession of elliptical shapes that chain up along a spine road. Parking lots are located under the spine road. The concept of satellite was also abandoned in the main design of Terminal 2. Instead, airplanes can park directly in contact with the terminal buildings which gathers not only the check-in and security facilities but also the boarding gates. But some parking spots have been designed away from the terminal, on the other side of the taxiway directly passing along the buildings. In that case, passengers are processed to the terminal either by a regular bus or by a transporter bus able to adjust its height, preventing passengers from walking up and down the stairs. These transporters use the road located between the building and the aircraft. Passengers disembark as if they had used a conventional jet-way.

By looking at Terminal 2, we can distinguish two main architectural phases. The first one encompasses sections A, B, C and D. These sections correspond to the older parts of the terminal.

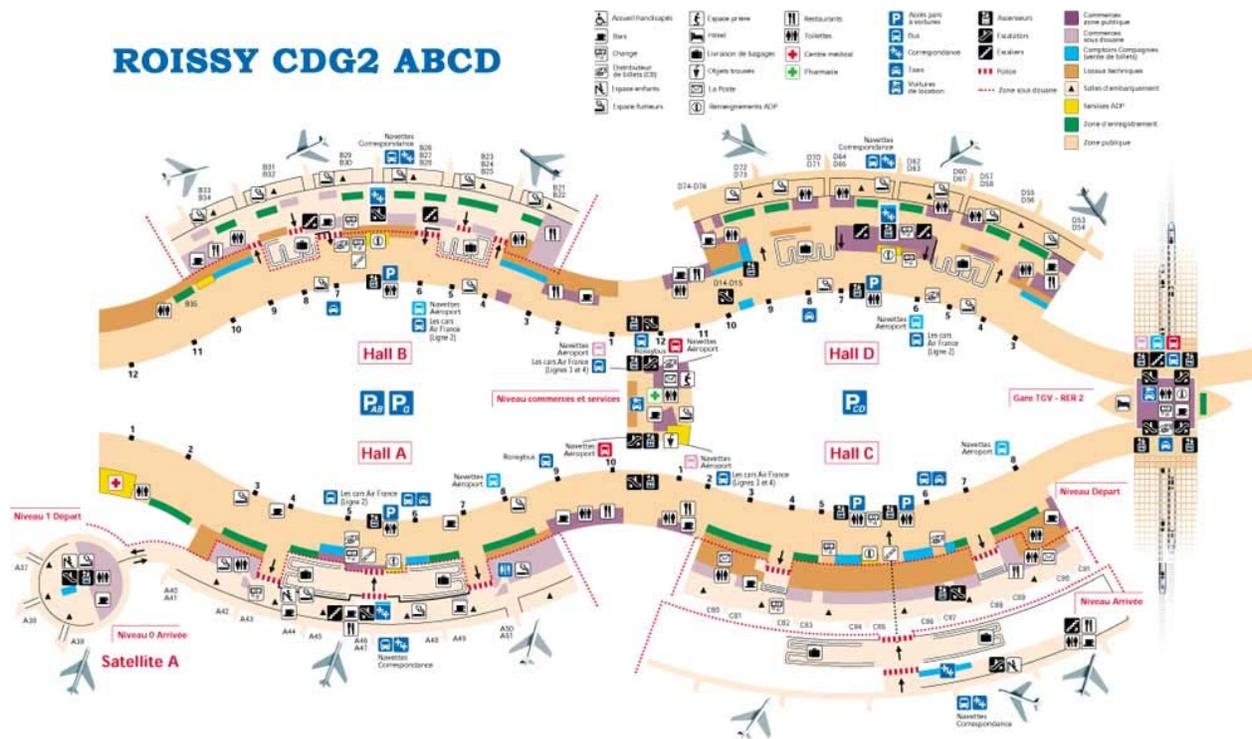
Section A and B were inaugurated in March 1982 by French President Mitterrand. Some innovative features were associated to these facilities. They were the first airport terminals in France for which security issues had been part of the design constraints. Aircraft operations were assigned to these sections according to their destination ranges. Terminal 2A has handled long-range traffic, while Terminal 2B has dealt with short and middle-haul flights. Both of these sections abide by the logic of the linear concept. For instance, Terminal 2A was built with 6 jet-way access gates. Operations and passenger processing inside that section were compartmented correspondingly, so that each boarding gate has its particular waiting room, its set of designated check-in counters and its own baggage handling system. The perspective lying behind this organization is to decrease the walking distance for passengers. In these cases, considerable progress was achieved compared to Terminal 1. The actual distance

between the sidewalk of this building and the aircraft gate is around 170 meters. In the meantime, the separation in the baggage handling system between the different gates has helped avoiding reproducing the troubles that have been encountered at Terminal 1, where luggage pieces were often badly conveyed.

However, these choices do have their share of drawbacks. First of all, ADP designed terminal sections that were too small to meet the flow capacity requirements that would allow each gate to handle 10 flights a day. Due to a lack of space, but also a lack of flexibility inside the terminal linked to the compartmentalized layout described earlier, building 2A and 2B gates have only been able to handle 6 and 8 flights a day respectively. Also, the linear concept entailed a lack of flexibility in that it is impossible for any passenger to check-in for their flight before the check-in procedures for the previous flight occupying the same gate are over.

Sections D and C were opened, in March 1989 and June 1993 respectively. These buildings share the same architectural design than sections A and B. Here again, traffic was divided according to destinations. Each new section came up as a natural extension of the two older sections. Hence, Terminal 2C has been handling long-haul international traffic while Terminal 2D has been dealing with short and middle-haul traffic. Some modifications have been based on a study of the older sections' flaws. Operations have no longer been compartmented in smaller parts. Each check-in counter can be assigned to any flight departing from the section. In the meantime, the boarding area is no longer divided according to gates; instead, a unique waiting area has been set up, which guaranties a much stronger degree of flexibility of operations between gates. As for section 2C, the baggage claim area has been located on a lower level, which has freed some space for duty-free shops in the waiting area.

Here is a layout of sections A, B, C and D.



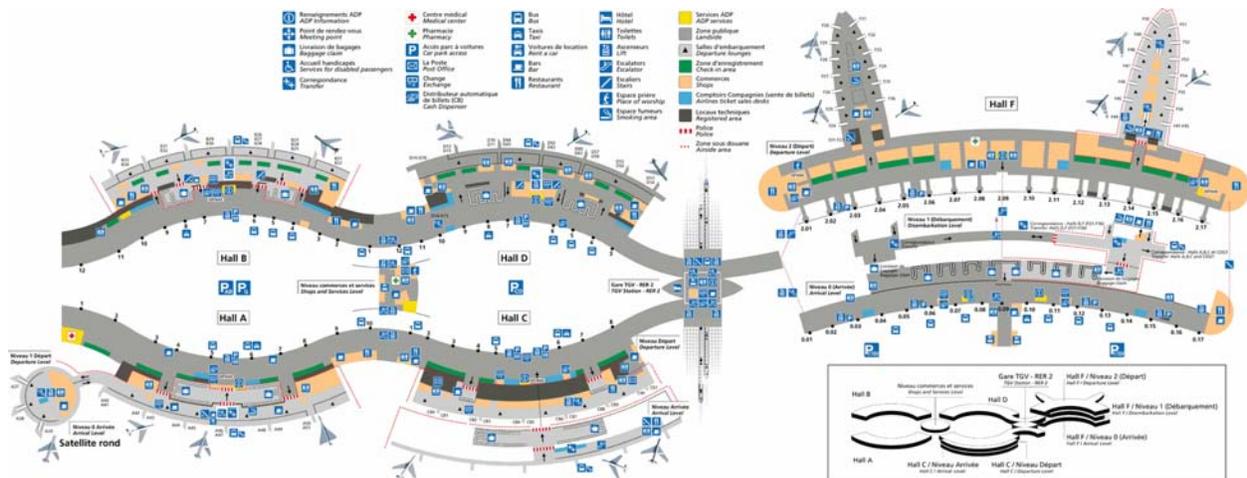
Source: www.adp.fr

The second and more modern architectural phase of Terminal 2 encompasses sections 2F and 2E as well as satellite 2A. Their design is again the work of chief architect Paul Andreu. The apparent and blunt concrete structure of the older parts has disappeared from the outside view to give way to rounded metallic and glass vaults.

The satellite consists in an extension of section 2A and can accommodate 3 wide body jets through 6 jet-ways.



For their part, sections E and F are much larger than the older sections and shape the third ellipse on the spine road. Each of them is designed to accommodate 6 million passengers a year. The number of jet-ways is much larger than for the older sections, with 24 for section F and 16 for section E. They both handle departing traffic on the first level and arriving traffic on the lower level. In the case of section F, separation is made directly at the exit of the plane, each jet-way giving access to both levels. Section F consists in a wide hall along the ellipse, gathering both check-in counters and shops. Security checks are placed at the entrance each peninsula where gates are located.

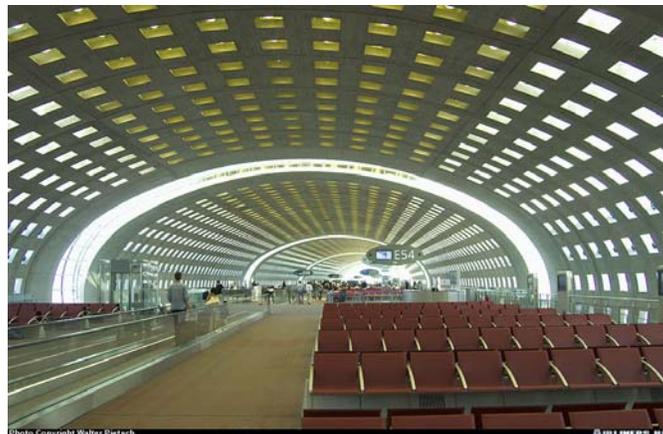


The peninsulas actually consist in wide boarding areas, as seen on the following picture:



One peninsula is dedicated to international long-haul flights and the other is used for flights within the UE-Schengen countries.

As for section E, while the public area is identical to the one of section F, the boarding area consists in a long hall-way, with an elliptical vault made out of concrete.



Passengers are more likely to encounter longer walking distances in this case, than in Terminal 2F. I should underscore the fact that these two designs recall the ones of the two terminals at Orly airport. Passengers are however handled in a totally different way.

These two sections are organized around a requirement for flexibility in passenger and gate handling.

As the national carrier, Air France, who is also the main operator at CDG, has been closely involved in the development of this airport and has always been given exclusive access to the newest facilities. With the opening of Terminal 2, the airline left Terminal 1 and kept on moving its traffic from Orly to CDG. Since 1993, Air France has almost stopped operating non-domestic destinations out of Orly airport. In 1995, it started operating CDG as its hub. But the linear design is causing inefficiencies in connection times. Walking distances from one section to another can be very long and getting from the sections located on one side of the spine road to the ones located on the other is not obvious either as there are only 2 connection points, located where the ellipses meet. I already had to connect from Terminal 2E to Terminal 2B. The Air France attendants warned me beforehand that this connection could take 20 minutes by foot and advised me to use the special shuttle bus circulating on the access road passing along the different buildings. This process may seem less tiring, but it involves several level changes as well as bus wait, which does not necessarily shorten the connection time.

Terminal 2 handled overall 34.7 million passengers in 2003. It is essentially the operating center for the SkyTeam alliance. Further extension of Terminal 2E is being built and should be open to public by 2006. In the meantime, the already existing part is being modified following the partial collapse of the boarding area's roof, last May.

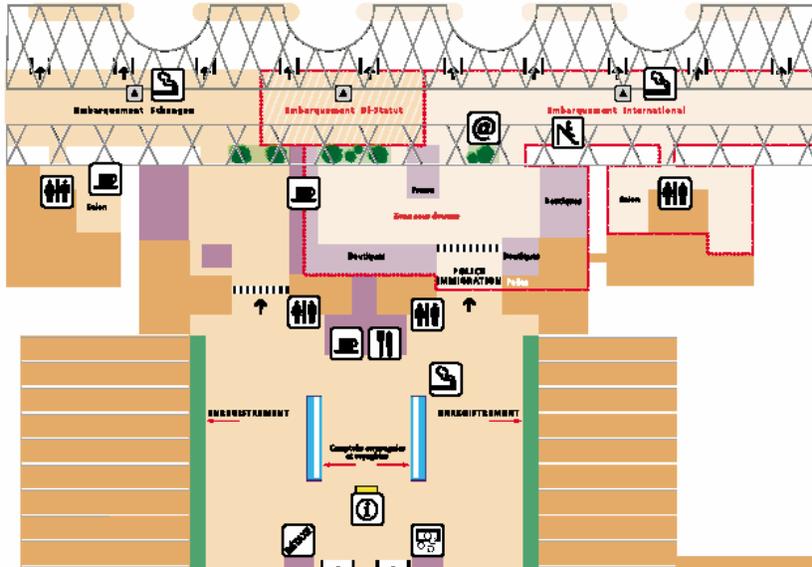
2.3 Terminal 3

Inaugurated in spring of 1990, Terminal 3 is dedicated to charter flight operations to and from CDG. Its design is based on the concern set to serve the special requirements of charter flights. Contrary to the main two terminals, this facility, which was first named T0 and then T9, is characterized by the simplicity and the “insignificant aspect” of its design. It was definitely not meant to contribute to the showcase ADP architects tried to put up with the two main terminals.

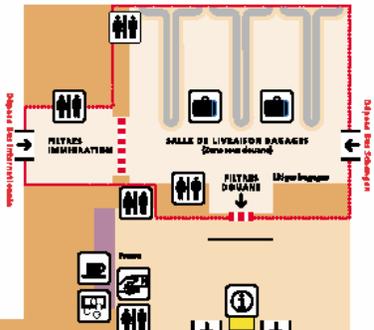
As it is meant to deal with charter airlines who have been wishing to pay less airport fees, Aéroport de Paris built this facility that literally looks like a white hangar from the outside. Cheaper materials have been used for the building that does not show any special architectural feature. Instead, its organization is based on a strong sense of rationality. The entrance hall gathers the check-in facilities as well as the sanitary service offices. The police control and security check points separate this entrance from the boarding rooms. No jet-way has been built. This terminal can be classified as a “plane-less” one in the sense that passengers are brought by buses to their plane. Although some disruption is undergone in the boarding and de-boarding processes, this approach poses less of a problem as charter airlines are less submitted to time schedule constraints as regular carriers. In the meantime, they operate Airbus 320s and Boeing 737s or 757s, which can accommodate 150 to 220 passengers, which does not require too many buses for transferring passengers. Since this terminal is a one-story building, the arrival traffic is handled in a second hall on the same floor.

Terminal 3 has known a lot of success. It was extended and renovated in Spring of 1999. In 2003, it handled 4.2 million passengers – 8.7% of the total traffic at CDG, which corresponds to a little bit less than half of the traffic that went through Terminal 1, for a land area that is far less than half of that of the latter facility. Over 150 airlines use this building.

Plan du Terminal 3



- Bus
- Change
- Distributeur de billets (CB)
- Espace enfants
- Espace famille
- Espace handicapé
- Ultrason de bagages
- Restauration
- Régénérateur ADP
- Téléphone
- Bus
- Taxis
- Commerces zone publique
- Commerces sans douane
- Compagnies (Compagnies et Voyageurs) (Vendeurs de billets)
- Locaux techniques
- Péage
- Salle d'embarquement
- Services ADP
- Zone d'embarquement
- Zone publique
- Zone sans douane



200m
 Nouvelle Adroport
 Vers les bus de la Gare routière et RER

Départ

Part de stationnement

Routibus

Arrivée

Source: www.adp.fr

3 Around the terminal buildings

3.1 Accessibility of the airport

Paris Charles de Gaulle airport is located 30 km North of Paris. Its accessibility from the Paris Downtown area has been taken into account in the design of the airport. In his book, "Airports and Environment", ADP's Director of Planning and Development Jacques Block underscored the importance for an airport to be located as closely as possible to the city it serves: "Locating an airport at great distance is [...] in contradiction to the outstanding feature of air transport, namely, speed.". He portrayed the high speed train solution as an extremely costly and poorly efficient solution, as it does not solve the problem of waiting times. In this context, the Paris Airport Authorities managed to find an ideal site.

Charles de Gaulle airport was also built as France started to modernize its road system and build new highways. The airport is now located on the path of Highway A1, linking Paris to Lille and Belgium. This highway has given the airport a high capacity access axis. This solution was even more interesting as there has never been air connection between Paris and Lille, passengers have thus been able to transfer easily by road. With the expansion of activities in the outskirts of Paris and in the economic pool around the airport, a net of highways has been built to link the airport to the entire Paris region.

On March 30, 1976, a direct railway connection called "Roissy Rail" opened between the airport and Paris. In 1981, it was integrated as an extension to line B of the Paris commuter rail system RER.

But one of the most interesting features in the different accessibility means to Charles de Gaulle is the interconnection railway station located between the last two ellipses of Terminal 2. This station links the airport to the French high speed railway system TGV.

It was built as part of the development of the Northern track linking Paris to Lille, Brussels and Amsterdam, and the extension of the South-East track between Lyon and Marseilles. Once again, the design of the facility was given to Paul Andreu. This project has represented another opportunity to show the modernity and the technological capacities France has been capable of. In the meantime, it has provided easy access to a convenient and reliable railway system, that has been formerly Air Inter's, and today Air France's main competitor on the domestic market. With this system, a passenger can reach downtown Marseilles in 3 hours. The same trip by plane would take them two and a half hour, taking into account the processing times from Marseilles' airport to the downtown area. We should also point out that the SNCF proposes the same number of frequencies as Air France, with 6 to 7 direct trains a day, compared to 6 flights a day for the French airline.

These previous points show how much emphasis authorities have put on the accessibility of the airport. A new project is now under discussion. The feasibility of a new high speed railway between the airport and Gare du Nord is being studied, to improve the connection times between the airport and the Northern part of the city. Such a project comes in opposition to the point of views of the former ADP officials, as we have explained earlier.

3.2 Transfers between terminals

The connections between the different terminals at Charles de Gaulle are done through an organized and coherent system of shuttle buses. But Aéroport de Paris is currently implementing a railway system of a special kind to fulfil this task.

Authorities were very early aware of the risk of congestion for the shuttle bus system. In the early 1980's, they started thinking about a mechanical system to complete a link between the different terminals. The VAL system, developed by the French company

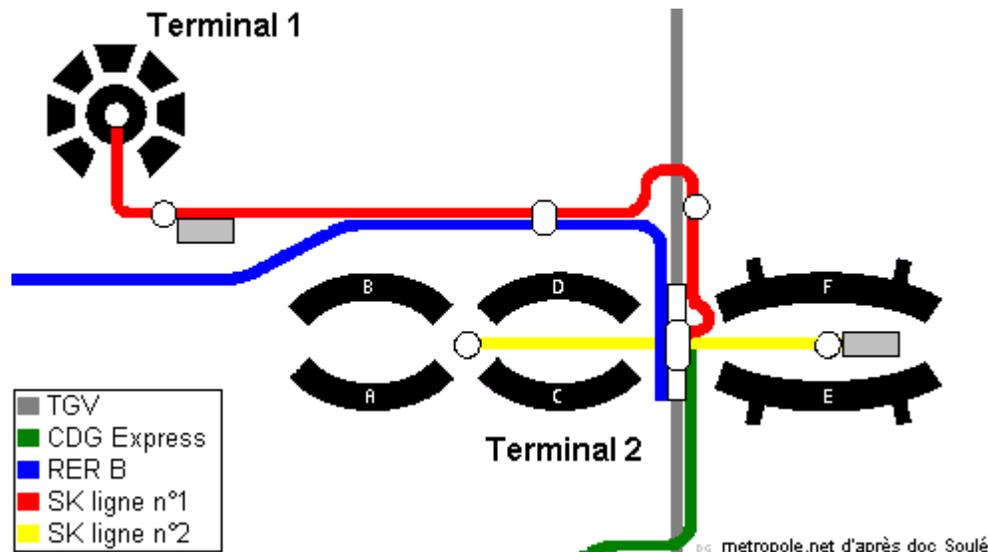
Matra and already in use at Chicago O'Hare at the time, seemed to perfectly meet the requirements for the new Paris airport. But continuing political changes in France progressively disadvantaged the reliable VAL system, to the benefit of a system derived from the ski lift moving mechanisms, called the "SK". This product was developed by the French company Soulé, which already equipped many ski resorts. It consisted in cabins of a capacity of 29 persons moving on rail tracks and pulled by a cable moving at constant speed. The system allowed a speed decrease or even a full stop of the cabins in the stations.



But this mechanism is meant to be used on short distances, i.e. on the order of several hundred meters. At CDG, it would have actually been used on several kilometers, on curved lines involving many stops. This geometrical path triggered many cable problems as well as speed instabilities.

Two lines were planned to be built, at that time:

- ✘ The first one would have linked Terminal 1 to the TGV station via the economic center of Roissy Pole
- ✘ The second one would have linked the different sections of Terminal 2 together.



The entire system would have consisted of 79 cabins, moving at a speed of 36km/h which would have insured a capacity of 5000 passengers per hour. It was designed to be accessible to handicapped people and luggage carts.

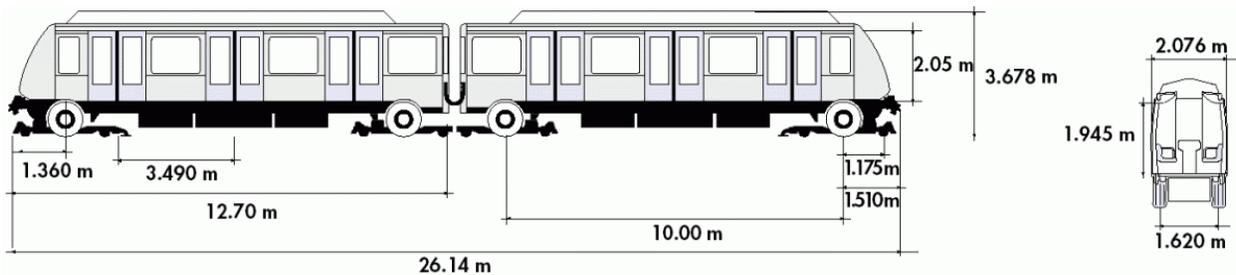
Line 1 was finished in 1996, but many technical problems linked to the moving mechanism of the system emerged. It also proved to be very noisy, which did not satisfy the Sheraton managing staff located on top of the TGV Station. The project was finally abandoned after 3 years of desperate improvements and at a cost of € 148 million.

ADP decided to find another contractor for its Automatic Transport System (SAT). The contract was won in 2001 by Siemens Transportation Systems and Keolis. It originally planned on building 3 lines.

- ✘ The first one will take over the track built for line 1 of the SK. It is 3400 meters long.

- ✘ The second line would have taken over line 2 of the SK and linked the different sections of Terminal 2. The project was abandoned. The parts that have already been built for the SK could be integrated as an extension to line 1.
- ✘ A third and new line is scheduled to link the main building of Terminal 2E to the satellite terminal closing the spine road of Terminal 2.

The train system will be a VAL of the same type as the one in operation in Lille. It will be a fully automated train operated 24 hours a day, 7 days a week. The capacity of the system will be of 4800 passengers an hour.



Source: www.metropole.net

Siemens and Keolis will be responsible for operations and maintenance for the first 6 years. The overall cost of the construction work and the trains are estimated to €150 million. Opening of line 1 is scheduled for 2006.

Conclusion

All along this study, we have analyzed the developments France's main airport facility has known since 1964. What was then a region covered with thousands of acres of fields has now become a real economic lung for Paris. This airport saw 48.2 million passengers in 2003, which ranked it as the 8th largest airport in the world. It handled 505,500 aircraft movements.

Today, it is the only non-US airport to be fitted with 2 independent pairs of parallel runways. It covers 3,254 hectares, which corresponds to one third of Paris.



75,500 persons work at this airport in some 700 companies. The total turnover generated by the activity on this platform is estimated to € 7 billion, while it triggered a fiscal revenue of € 148 million.

This airport has now become a real center for transportation and exchange, Air France's hub and literally the gateway to France.

However, we have been able to underscore the different flaws in design this airport has been victim of. The strong will to present this gateway as the symbol of the French creativity in architecture and savoir-faire in civil and aeronautical engineering has led to somewhat dogmatic choices that have not served operations well. The constant necessity to change levels at Terminal 1, the inefficient design with regard to hub operations at Terminal 2 or the latest tragedy at Terminal 2E, with the collapsing of the roof of this supposedly state-of-the-art facility, are cases in point of a certain lack of pragmatism or care for efficiency from the state authorities. Terminal 3 stands here as a noticeable exception. Authorities may want to inspire themselves from the models that have already been developed around the world for the future extensions of the airport, if ever.

CDG is indeed still growing. A third control tower is being built next to Terminal 1. The current capacity is of 55 million passengers a year. That threshold should be reached within this decade. But the future looks very dissimilar from the predictions Jacques Block made in his book. He forecasted that from 1985 on, airports would no longer need to grow because of the advent of STOL and VTOL aircraft that would allow the development of "vertiports" on top of the buildings in the downtown areas.

A few years ago, a debate was opened about the construction of a third airport for Paris. Plans aimed at a site located 80 KM North of Paris. The recent merger of Air France with KLM put this issue on the side, and presented Schiphol as a possible answer to this issue.

References

- Chronique de l'Aviation - Ed. Chronique Acropole
- Airports and Environment – Jacques Block – Edition Aéroports de Paris.
- International Airport Planning as Influenced by Aircraft Development – Lecture by J.V. Block to the Royal Aeronautical Society – London, December 2nd, 1968
- Roissy – Charles de Gaulle: 30 ans de développement économique et de partenariat local. Document ADP.
- Guide ADP juin 2004.
- www.adp.fr
- Rapports de comités du 6^{ème} plan 1971-1975, Transports Aériens.
- <http://www.airliners.net>
- <http://www.metro-pole.net/reseau/lignes/cdg/sk.html>
- <http://www.metro-pole.net/reseau/lignes/cdg/val.html>
- <http://www.paul-andreu.com>