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**THE STRATEGIC PROFILE OF CNES**

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**THE STRATEGIC PROFILE OF CNES**

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## 1. Overview

### 1.1 Resources

#### 1.1.1 Financial resources

According to current data in the accounting report for 2005 (Table 1), the French Space Agency (CNES) had funds of 1714 M€ in 2005, of which 1366 M€ (80%) were directly allocated by the French Government and 348 M€ (20%) came from external sources (results of exchange operations with the market). These resources were mainly allocated to national and multilateral programmes (52%) and to the ESA (40.2%) as contributions; the remainder was spent on running CNES (3.5%) and on taxes (3.9%). From table 1 and 2 can be also observed that there was a significant reduction in functional expenses in the last years.

Table 1: CNES Funds and Expenses Budget (2004 and 2005)

(Millions of Euro)	2005	2004
<b>FUNDS</b>		
French Government	1366 (80%)	1361 (80.5%)
External sources	348 (20%)	329 (19.5%)
<b>TOTAL FUNDS</b>	<b>1714 (100%)</b>	<b>1690 (100%)</b>
<b>EXPENSES</b>		
Contribution to ESA	685 (40.2%)	685 (41%)
National and Multilateral programmes	893 (52.4%)	861 (52%)
Functional expenses and others	60 (3.5%)	73 (4%)
Value Added Tax (VAT)	66 (3.9%)	51 (3%)
<b>TOTAL EXPENSES</b>	<b>1704 (100%)</b>	<b>1670 (100%)</b>
<b>NET RESULTS</b>	<b>10</b>	<b>20</b>

Source: CNES annual report 2005

Table 2: CNES Revenue and Expenditure (2001-2003)

(Million of Euros)	2003	2002	2001
<b>REVENUE</b>			
Government subsidy	1308 (76%)	1335 (69%)	1326 (74%)
CNES's own resources	401 (24%)	583 (31%)	464 (26%)
<b>TOTAL</b>	<b>1709 (100%)</b>	<b>1918 (100%)</b>	<b>1790 (100%)</b>
<b>EXPENDITURE</b>			

Contribution to ESA	640 (37%)	685 (36%)	641 (36%)
National and Multilateral programmes	459 (27%)	621 (32%)	518 (29%)
Functional expenses and others	557 (33%)	563 (29%)	576 (32%)
VAT	53 (3%)	49 (3%)	55 (3%)
<b>TOTAL</b>	<b>1709 (100%)</b>	<b>1918 (100%)</b>	<b>1790 (100%)</b>

FONTE: CNES annual report 2001-2003

### 1.1.2 Human resources

The agency had 2449 employees at the end of 2005 (See Table 3).

CNES has technical facilities, including laboratories in Toulouse (satellites & a ground segment), in Evry (launchers), in Kourou (a launch pad), and none in Paris. In Evry, CNES does not have laboratories as it does in Toulouse. In Toulouse there are approximately 1711 employees, of which 1000 are technicians.

From table 3 can be also derived a decreasing trend for number of CNES employees in the last five years.

Table 3: CNES Employees

<b>EMPLOYEES</b>	<b>2005</b>	<b>2004</b>	<b>2003</b>	<b>2002</b>	<b>2001</b>
Women	863	848	884	894	889
Men	1586	1616	1642	1686	1719
<b>TOTAL</b>	<b>2449</b>	<b>2464</b>	<b>2526</b>	<b>2580</b>	<b>2608</b>
Paris	220	230	247	262	260
Evry	243	241	250	256	247
Kourou	275	268	287	297	318
Toulouse	1711	1725	1742	1775	1783
<b>TOTAL</b>	<b>2449</b>	<b>2464</b>	<b>2526</b>	<b>2580</b>	<b>2608</b>

SOURCE: CNES annual reports 2001-2005

## 2. Organizational profile and Governance

### 2.1. Organizational structure

The organizational structure of CNES follows a functional model and includes (see the annex 1):

- the Chairman (CEO)

- at the top of the structure is a General State Controller in charge of controlling the use of funds allocated by the French Government, plus a nucleus of Directors from the Ministry of Defence and one Associate Director General in charge of strategies, planning and international relations. These positions have a strategic significance, as is pointed out later in this document.
- in line are positioned the Toulouse Centre Directorate (R&D), the Launcher Directorate, the Kourou launch centre Directorate in Guyana, the Purchase and Sales Directorate (these are considered “Line” Directorates); “Staff” Directorates include the Directorate of Human Resources and Social Affairs, (from which depends the Information System Directorate), the Programme Quality Directorate, the Directorate of External Communications and Education, and the Finance Directorate.

## **2.2. COMEX**

Comex is the executive committee. It is responsible for the evaluation of high level people, investment, financial decisions, project decisions, strategy and policies.

The following people are in Comex: D’Escatha, Moskwa, Germain, Janichewski, Ulrich, Cuquel, Trefouret, Marce, Eymard, Dorrer, Mamode, Assemat.

## **2.3 Board of Directors**

On the Board of Directors there are 8 government representatives, 6 elected personnel representatives and 4 government-appointed experts. They are in charge of discussing strategies and major contracts. Mr. D’Escatha is the Chairman of the Board. Beside this board there is also an audit committee. Mr. Cuquel is the Secretary of the Board.

## **2.4 Why changes were made to agency organisation and management**

The aforementioned organisational structure is the culmination of a major shake-up, which took place after the appointment of a new CEO, Mr. D’Escatha, who joined in February 2003. This shake-up was due to two reasons:

- the failure of the first ARIANE 5-ECA flight in December 2002. Said failure led to the destruction of two major telecommunications satellites in which the French had placed a great deal of hope (including the TESTIR satellite). A comprehensive review of the European Space Agency mission (ESA) in the wake of the failed launch incurred enormous financial losses;
- CNES had launched an excessive number of projects and did not have sufficient resources to cover them all; consequently the Agency’s planning system was also brought into question.

### **2.4.1 Profile of CEO.**

Mr. D’Escatha is a mechanical engineer with an extensive background in research and training. He quickly worked his way into top-flight management: before being appointed to CNES, he was Chairman and Director General of a nuclear industry company, after which he became Chairman of the French Atomic Energy Commission (CEA). He was then appointed as Associate Director



General of Electricité de France (EDF). Consequently he has had solid managerial experience both in the public and private sectors. When he arrived at CNES, he assigned all decision-making powers to his role as CEO (merging the previously separate roles of Chairman and Director General).

#### 2.4.2 Reduction of hierarchy and Merging of roles

Mr. D'Escatha introduced some major changes. He merged many of the roles within the CNES organisational structure according to complementary criteria; he also reduced the hierarchical levels from five to three, both within the general structure and each individual department as required by lean management.

Another major step was the concentration of strategy, planning and internationalisation into the hands of the Associate Director General because CNES policy requires agency programmes to be multilateral wherever possible.

Passing from a 5-level to a 3-level organisational structure within each Directorate entailed a major overhaul of organisational roles.

#### 2.4.3 Planning system

Company planning was also reorganised and involved re-evaluating programmes and establishing new priorities; major intervention also took place in the reorganisation of ESA programmes, which culminated in the Ministers for Research deciding to use ESA launchers for all agency programmes. CNES played a key role in pushing towards this decision.

#### 2.4.4. Operations planning system

Mr. D'Escatha also oversaw a review of the operations planning system and company control. He introduced a budgetary mechanism that was linked to a Management By Objectives system. This innovative step was backed up by a far-reaching human resources development policy.

#### 2.4.5 The matrix organization in Toulouse<sup>1</sup>

The main organisational change in Toulouse in 2002 was the introduction of a matrix (see annex 3). Implementing the matrix structure meant having to deal with extensive cultural change as it involved introducing managerial and organisational best practices, mainly from private businesses. Toulouse is a Directorate organised into Subdirectorates (see Fig. 1 below). All specialists in the same discipline are allocated to the same Subdirectorate and these specialists are responsible for each project. Hierarchically, they answer to the Subdirectorate manager and operationally are directly responsible to the Project leader. The Project team is in a specific Subdirectorate ("projects orbitaux"). All other Subdirectorates delegate specific people.

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<sup>1</sup> Although the official organizational structure is a functional one (see annex 2), from the empirical analysis conducted in October 2006, a matrix structure clearly emerged.

Fig.1: Organisational structure, Toulouse.

Toulouse deals with orbital systems and has 14 Subdirectorates within its organisational structure:

- Subdirector of Technical Management: Mr Assemat (Subdirectorate “Dir. Ajointe”)
- Subdirector for Observation payloads and Scientific payloads: Mr. Avignon. This Subdirectorate also deals with both optical payloads and optical technologies;
- Subdirector for Platforms, buses, equipment and projects: Mr Boloh;
- Subdirector for Quality Assurance: Mr. Bourdeil. He is responsible to Mr. Cuquel. This Subdirectorate deals with: PA (Product Assurance) engineering, EEE, SW quality, material processes engineering, documentation and configuration, failure analysis and non destructive analysis laboratories, and component engineering analysis. CNES does not have its own radiation laboratories and uses the facilities of Onera and the CEA. For payloads and spacecraft, it uses INTERSPACE, but for small masses (components) small vibrators are available in the Quality Sudirectorate, while for medium masses, vibrators are available in Mr. Boloh’s Mechanical Subdirectorate.
- Operations Subdirector: Mrs (Campan. This Subdirectorate is in charge of putting satellites in orbit and monitoring them once they are in space. It is the equivalent of the ESOC at the ESA. The equipment used belongs to CNES and is located in Toulouse. Naturally the satellites are monitored by an international network of earth stations. Agreements are in place with international organisations in Canada, Australia, Russia and Europe, as well as with NASA. Toulouse has antennae, computer and control centre facilities, etc.
- Balloons Subdirector: Mr.Cazaux. CNES is heavily involved with balloons. For CNES, balloons are like platforms (buses) and payloads are mounted on them. It is a highly cost-effective way of making a launch. CNES carries out launches from the south of France, Africa, Brasil, Sweden (Kiruna), and sometimes from South Africa. It makes many launches a year (well over ten) and has a fairly large budget for this activity. Its most important clients are scientists. It is an independent line of missions. Balloons are sometimes used to test technology; e.g. they were used to launch Gallium arsenide solar cells made by CISE. This Directorate employs about 50 people.
- Project Management Subdirector: Mr. Goudy. This is a crossover function that deals with a range of Subdirectorates and encompasses Project Managers, System Managers, etc. Small Project teams are created.
- Radiofrequency Subdirector: Mr. Lafuma. Dedicated to RF technology related both to payloads and to platforms
- Support and Purchases Subdirector: Mr. Le Guen. In charge of support, purchases and procurement, centre safety and logistics (water, electricity, security etc). It is also in charge of the cost control function. This sudirectorate also includes people in charge of negotiating contracts with industrial contractors in cooperation with the Project team. There are three purchase units: one for projects, one for informatics and for routine purchases.
- Ground/Board System Subdirector: Mr. Marchal. In charge of flight dynamics, GNC (Guidance, Navigation and Control) systems, AOCS systems.
- Human Resources Subdirector: Mr. Nabet. In every CNES centre there is a group of people in charge of local human resources who report functionally to this subdirectorate.
- Products and Ground segment Subdirector: Mr. Winterholer. In charge of all the informatics projects, such as project management S/W, data management and archiving, and ground

segment S/W. Usually it specifies the S/W and uses external companies for development. It manages three different types of S/W on its projects: Payload control centre S/W, Platform control S/W and data treatment and archiving S/W. The approach is to avoid proliferation of different S/W.

- Public Relations Subdirector: Mr. Pellat is in charge of local (Toulouse area) communications to the public, especially regarding local events, VIP visits and related arrangements.
- The subdirectorate "Comité d'établissement" is in charge of the following activities: installation (thermal station, power station, etc.), extraordinary maintenance, canteen, security, etc.

This new organisation is based on technical units called Subdirectorates, which are divided into departments such as optical, informatics and radiofrequency. There are also Project teams, including a Project leader, who deal with configuration control, documentation and project responsibility. Technical integration takes place in Mr. Boloh's Subdirectorate (platforms, buses, equipment and projects), which deals with vehicle technology, buses, satellite integration, thermal problems, mechanics, electrics, power and all other bus-related technology. The Subdirectorates are responsible for preparing project specifications, but sometimes are also required to develop projects in their own right. For large programmes, CNES writes the specifications and Alcatel and Astrium design and construct the satellites.

For the MIRIADÉ programme (a small 100 kg platform), however, a project was designed in-house at CNES; the aim was to keep minor technical activities in-house in order to ensure the technical competences of its employees were always up-to-date (this proved to be a fundamental strategy).

Technical competences can be kept up-to-date with a range of methods, including R&D and by having laboratories in the Subdirectorates. There are three main technical activities: R&D, Project and Exploitation, namely the technical activity that takes place when the satellite is in orbit. The latter simplifies the job of those monitoring the orbiting satellite, but is also a means of learning about new technology.

An engineer from a Subdirectorate is assigned to a project or to several projects if they are small ones. In each Subdirectorate there are departments dedicated to a specific technological area, in which CNES develops and keeps technical competence up-to-date; in the same department there are a range of people who have the same competences, and if an engineer is missing for any reason (sickness, retirement, vacations, etc), he can be substituted easily. A project team is a virtual team, i.e. the engineers are not moved and remain in their rooms. Only in a few cases does CNES set up a "tiger team" team room, while the analysis of a new project (phase 0 and phase A) is usually carried out in the "concurrent engineering" group. For the successive phases starting from B, CNES establishes a project team based on the matrix, as described above.

The person responsible for the technical results is the Project leader and not the Head of the Subdirectorate.

A sort of contract is agreed between the Project manager and the Head of the Department. This contract is identified by the work that has to be performed, the qualification of the people and the number of engineers. If the project has an anomaly in the course of its life, the person responsible is the Programme manager.

The Heads of Department are responsible for recruiting, training, managing R&D, managing people and activities, ensuring that engineers respect standardization, Vision 2000 etc. The heads of the technical departments are not responsible for the technical project, but have to verify that the performance of the engineers meets expectations, provide tools (H/W and S/W) and maintain high levels of technical competence.

#### 2.4.6 The creation of the “Information system” Directorate

This is one of the main changes between the last organization and the current one. The main topic is the introduction of SAP. Around it CNES has developed many specific SAP applications, but they have discovered that every time there is a new version of SAP, they have to rewrite all the specific applications, and this creates big costs and effort. So they have decided to simplify the system and to keep only the basic function of the kernel of SAP. This Directorate has introduced a S/W policy, according to which when a specific S/W tool is developed, it must be applied to all CNES centres. This Directorate is in charge of all the S/W for:

- ground segment development;
- ground segment operation;
- the information system;
- development of specific S/W.
- the subcontractor in charge of operating the information system.

The total cost of the CNES information system is about 100 million euro per year.

As for the physical size of the information system network H/W, CNES has two networks, one for standard and bureaucratic applications (e-mail, internet, reports) and one for technical and scientific S/W tools (CAD CATIA 3D, mission analysis, CASE, flight dynamics etc). For these tools, CNES prefers to procure standard S/W from the market, instead of developing new tools. In a few cases, CNES develops its own tools, as is the case with flight dynamics S/W.

On average there is more than one computer per person.

#### **2.5 Quality Directorate (“Inspecteur general, Direction de la fonction Inspection General e Qualite”)**

This Directorate is responsible for quality, internal auditing and safety.

Quality has a wide meaning and generally covers the quality of all CNES activities (projects, management, services, information systems). CNES is certified in accordance with Vision 2000 and this Directorate is also responsible for the Vision 2000 programme. CNES has a single Vision 2000 certificate which covers all CNES centres (Paris, Toulouse, Evry and Kourou); each centre has a Quality department that hierarchically answers to the Centre Manager and operationally is responsible to this Directorate. Each centre has its own Quality manager: the operational link covers all the activities mentioned, including those regarding the Vision 2000 programme.

CNES has a quality policy that covers all the departments and naturally Product Assurance for Programmes and Products.

Personnel are divided as follows:

- The Directorate employs 20 people, including 2 for safety, 5 for internal auditing and 13 for quality;
- The Toulouse centre has about 80 – 100 people in the Quality department of a specific Subdirectorate;

- The Evry centre (launchers) has about 30 people in the Quality department of a Subdirectorate;
- The Kourou centre has about 20 (in a department that is not a Subdirectorate but a “service”);
- In Paris, no people are directly involved as there is only one Quality representative for each Paris Directorate.

Quality involves a total of about 200 people, i.e. 10% of all resources. This value is traditionally considered a benchmark for anyone working in the space industry.

## **2.6 Future evolution of the CNES organization**

In the near future, evolution will probably regard administration activities. Today cost control and financial management are dealt with by the Support and Purchases Subdirectorate. Future organization, probably next year, will see cost control and financial management allocated to the Finance Directorate under Mr. Germain. Today there is an operational link between the Finance Directorate and the financial units that are in the Subdirectorates, and a hierarchical link with the Head of the Subdirectorate. In the near future, it will be the opposite, i.e. a hierarchical link with the Finance Directorate and an operational link with the Subdirectorate. The same should happen with procurement. The purpose is to create centres of competence throughout the company where all the employees do the same job.

## **2.7 Main differences between CNES and other European Space Agencies**

The main differences between CNES and other European Space Agencies are as follows:

- if one excludes Russia and a few other former URSS countries, CNES is the only agency that has major launch capabilities (Ariane launcher, the availability of Soyuz and, in the near future, of the “small launcher” Vega);
- military programmes play a key role in the activities of the Agency and in the decision-making process;
- CNES is the EU’s major contributor to the ESA; in 2005 its contribution to ESA funds was € 685 million, 24% of total ESA funding (€ 2854 million) and 20% of the total income of the ESA (€ 3399 million);
- since CNES has a large nucleus of qualified engineers and technicians (located especially in Toulouse, south of France) it has major R&D potential in the aerospace field; this characteristic enables the agency to lead companies that build space vehicles. By means of this leadership, therefore, CNES is more effective than the other space agencies and promotes the transfer of technology programmes; the companies involved benefit from these programmes. Toulouse is a point of reference for Europe’s main aerospace facilities;
- at the top of the organizational structure is a CEO who is both Chairman and General Manager of the Agency. Using this typically French model, the CEO assumes the decision-making responsibilities which, in British and American organizations, are shared between the Chairman

of the Board and the Chief Executive Officer (CEO). CNES Governance is also different in that six out of the twenty people sitting on the Board of Directors are personnel representatives.

### **3 Strategy**

#### **3.1 The role of CNES in France's politics and economics**

The agency was founded more than 40 years ago with the aim of achieving three main objectives:

- ensuring the country became a great military power, also by acquiring a strong position in space exploration and related technologies;
- promoting innovation in industrial systems; all French governments have stated the importance of space technologies for the development of industrial innovation. Over more than 40 years, huge investments have been made in space as well as in other sectors considered critical for the economic growth of France, such as the nuclear sector, the high speed rail and the agri-food sectors; this constant issue of French industrial policy has a direct connection with the “contrat pluriannuel Etat-CNES 2005-2010” signed on April 2<sup>nd</sup> 2005;
- playing a leading role among western European countries in the space industry. These objectives have been modified as time passed by polarizing the French effort in the direction of the “Europe in space” programme, which also encompasses “room for autonomy and confrontation as well as for cooperation with the U.S.A.” This is why CNES is a major contributor to ESA funding, is a firm advocate of the Galileo Program and, more recently (December 5<sup>th</sup> - 6<sup>th</sup> 2005) supported the agreement signed in Berlin by the Ministers for scientific research of European Union countries. This agreement envisages the exclusive use of European launchers for launching ESA satellites. This agreement was formally signed by the President of the French Republic, Jacques Chirac, in Cannes on March 9<sup>th</sup> 2006.

#### **3.2 CNES mission**

Official CNES documents define its mission as follows: “The mission of CNES is to propose French space policy to the French government and then to implement it, both within a European framework and with international co-operation. CNES has the capacities to participate in the development of scientific culture and to work towards the promotion of science among young people by exploiting the attractiveness of space”. In the most recent version provided by CNES, this definition is extended by specifying that the objectives of the Agency also include the application of space technologies to the development of Science, to the preservation of the environment and to the growth of an information society.

#### **3.3. CNES policy on company participation**

France makes a clear distinction if financial participation is higher or lower than 30%; if it is higher, it is considered a branch, if it is lower it is considered participation. CNES participates in many

companies, generally with a very small participating share (no more than 30%), but it does own more than 50% in two cases: CLS, which runs the ARGO system, and Telespace, which is a finance company. CNES has “only” a 30% share in Spotimage and in Arianespace, even though it is the major shareholder.

The strategy is to create and promote new initiatives in which CNES sees interesting commercial potential. After start-up and tutorship, the enterprise is transferred and continues on its own. For example, CNES is no longer a shareholder in INTERSPACE, while at the beginning it was; its shares were sold to ASTRIUM some years ago. Today INTERSPACE is an EADS company.

One key strategy is that CNES tries not to put itself in commercial competition with Astrium and Alcatel. In many cases, CNES has suggested creating new companies to Alcatel and Astrium, as happened with Telemedicina. CNES helps launch the company for three or four years and then leaves. Startup support is given because CNES is responsible for promoting space activities; any support provided is promotional and at times involves helping to create and stimulate a market. This means that CNES is not actually a client of these initiatives, but it is a formidable tool for lending credibility and enabling the acquisition of contracts and clients.

For meteorology, CNES helped set up Eumetsat and promoted it with public authorities. There was moderate help in terms of government funding. Spotimage is also the culmination of this strategy and deals with the opportunities surrounding earth observation.

### **3.4 Strategic issues of resource use**

CNES allocates its resources to the following programmes:

- sustainable development programmes, i.e. ones that preserve the environment in order to meet the needs of the today’s society, without jeopardizing the needs of future generations. The latest programmes in this category are related to the study of atmospheric climate (SIFTI program) and of the spectrum of ocean waves (SWINSAT program);
- scientific programmes (Space sciences); among them is the EXOMARS programme for the exploration of Mars in cooperation with ESA;
- defence satellites;
- civil applications, including the SDNB programme (Satellite Digital Mobile Broadcasting) which develops television on portable terminals;
- space transportation programmes. These include the FLPP Programme (Future Launcher Preparatory Programme) in cooperation with ESA. It aims to replace the Ariane launcher in 2010.

This type of space investment does not feature strongly in the account report of other agencies; therefore, Table 4 below is presented in order to enable a useful comparison between the accounts of different agencies and, in this specific case, to understand the relative weight of the various areas of investment as well as the related strategic importance given to CNES management.

Table 4: CNES investment in space programmes

	2005	2004
Launchers	35%	31%
Scientific programmes	13%	13%
Earth observation	11%	14%
Civil applications	5%	5%
Security and defence	17%	17%
Multilateral programmes	19%	20%
Total	100%	100%

Source: our processing of CNES data

The aforementioned CNES investment figures illustrate that:

- the majority of CNES funds are spent on launchers. This figure is not surprising because France has always sought to lead Europe within this field since the origin of the space industry;
- the second biggest investments are made in multilateral programmes and in security and defence. These figures also show that CNES has a clear direction; undoubtedly a strategic objective of CNES is to expand its influence beyond French borders by looking to lead Europe's space industry and, at the same time, by working closely with emerging Asian countries, particularly China and India.
- enormous importance is given to military programmes in CNES strategies.

### 3.5 The four pillars of CNES strategy

In brief, CNES aims to achieve the following long-term objectives:

- ensuring France spearheads Europe's efforts in the space industry; this can also be achieved via the strong influence CNES exerts over the European Space Agency, in that CNES is the major contributor to its budget, as already mentioned;
- maintaining and improving on its predominant position in Europe in the launcher sector. The recent deliberation of the Ministers for scientific and technological research for EU countries (held in Berlin on December 5<sup>th</sup> - 6<sup>th</sup> 2005) is heading in this very direction. This document instructs ESA to use only European launchers for its missions; this practically means that CNES manages the Ariane launches and that it will manage the Vega and Soyuz launches as well, thus completing its portfolio of small, medium and large launch capabilities.
- maintaining and to developing its leading position in both telecommunications satellites and in earth observation satellites; the latter objective can also be achieved by funding military satellites. In this area, the "dual use" initiative must be allocated. With the series of Helios satellites and the Pleiades constellation, France has confirmed that it has a high level of knowledge in space optics and in "signal intelligence";
- developing scientific and commercial relations in the space field with major Asian countries (China, Japan, India); it is reasonable to believe that, in this way, interesting markets can be



found for the aerospace industries, which are currently dominated by Alcatel and may be dominated by Thales in the future;

- reinforcing relations with the space industry system. This relationship has been very fruitful up to now; it is based on the conviction that any public money used via CNES must be geared towards reducing areas of uncertainty and risk related to innovative technologies stemming from the development of space missions.

The agency therefore selects the programmes on the basis of the following criteria: it looks for technologies that can be used to develop industrial applications in other fields. In order to implement this role, CNES uses a highly-qualified group of engineers and researchers (more than 1000 in total) who conduct experiments and then design the space missions so that they are able to define highly analytical specifications to be proposed to industry. This role of technological leadership is accompanied by a remarkable process of learning which benefits industrial enterprises.

#### **4 Aspects of strategic and operational planning**

The entire planning process is headed by the Associate General Manager, Mr. Janichewski, who is supported by two people. Mr. Janichewski, who is also head of the Strategy and International Relations Directorate, has 85 employees under him. His Deputy deals with the day-to-day running of international relations and is also Chairperson of the ESA Scientific Committee.

##### **4.1 Strategic planning**

The process starts with some general guidelines given by top management (review of results, any additional expectations of CNES stakeholders, identification of the boundaries of available resources.). Following this first top-down approach, the strategic plans of the Line Directorates and of the Staff Directorates are prepared (bottom up). In order to match the results of the two phases, external experts in organizational development are used. The next phase consists of preparing the action plans; a specific operations directorate is in charge of them, even though it reports operationally to the Director, Mr. Janichewsky. The strategic plan is formally reviewed every two years. The entire planning system (strategic and operational), however, is governed by the aforementioned five-year programme (2005-2010), which has been approved by the French government. This programme details the civil, military and industrial objectives to which the French government's space programme is committed, as well as the envisaged investments and the sources of funding for the main projects.

##### **4.2 Planning and control**

The planning and control system is based on internal negotiations; for example this means that the Paris Directorate negotiates programme objectives, technical characteristics, performance, costs and times with Toulouse's Operations Directorate. This negotiations system is the basis of a Management By Objectives scheme that applies to all Staff and Line Directorates and requires each one to provide a monthly report for each project launched. These reports are then sent to the Executive Committee, which is set up by the CEO, Mr. D'Escatha. The system also has margins

and does not seem to be punitive; in other words, if extraordinary circumstances mean that a project takes much longer than expected or its budget is exceeded, the Directorates have a “solidarity margin” and together they try to solve any problems. Naturally this system entails increased autonomy for the Heads of the Directorates, but does set out precise limits within which to act and transparent management regulations.

## **5. CNES programmes**

### **5.1. Selecting programmes and projects**

Selecting programmes and projects follows a rather complex procedure:

- Institutionally, the gathering of ideas for projects and programmes is the responsibility of Mr Janichewski’s Directorate, which also governs the entire programme choice and approval process;
- An internal commission evaluates and selects the projects according to a system called A2 (Atouts) A3 (Attrait). This approach consists of two main phases: the first entails evaluating the projects on the basis of their relevance to the requirements of stakeholders and to the strategies and interests of France, whilst the second involves evaluating the projects in accordance with the resources, competences and organisational system of CNES.

In particular:

- In the **first phase (A3)** the following four criteria are used:
  - o Project coherence with CNES strategies;
  - o The willingness of the project proponent to make the request formal (this often means a greater propensity to fund the project, as is the case for the military, for example);
  - o The availability of CNES resources required to implement the project/programme in question;
  - o The evaluation of expected programme results (scientific or technological results) and any fall-out.
- The criteria for the **second phase (A2)** are:
  - o Would our organisation be able to implement the programme successfully? Are we the best organisation for the job or do we have any technical or managerial shortcomings? This criteria refers mainly to space system competences and thus looks at the organisational and technical competences available overall;
  - o The second criterion makes specific reference to the technical expertise required;
  - o The third regards an evaluation of the potential costs that would be incurred to implement the project. The main point is a comparative evaluation of the costs and therefore of the efficiency of CNES in respect to other agencies. In practice, if CNES’s costs are lower than those of other agencies, it would be a good reason to consider taking on the project. The overall costs include both the cost of procuring the space segment and the agency costs;

- The fourth entails evaluating what resources, including what other organisations, may be necessary to complete the project, so that the programme in question can be configured as multilateral.

These criteria are evaluated by a CNES internal commission, which may also call upon external experts for advice.

## **5.2 Project development control framework**

The result of this work is a list of projects that are classified by portfolio logic, which takes account of and weighs up different requirements. In short, the evaluation procedure results in the creation of three project groups:

- a) Rejected projects;
- b) Leader projects;
- c) Projects that depend on what funds are available.

This method, assures Mr Janichewski, enables work to proceed according to priorities, and is much appreciated by the French government.

The framework of the project planning and control system consists of an excel matrix that cross references lines of activity with projects (i.e. the projects are placed within the lines of activity). Every six months, the progress of each individual project is checked and any necessary revisions are made. The points checked are the costs incurred, their origin and nature, the costs required to complete the project, the times, and the source of internal and external resources. This planning and control system could be termed managerial, while at a technical level each project is governed by a standard space project management scheme made up of a WBS by phases, actions etc. that develop over time.

## **5.3 Major CNES programmes**

In order to understand the data, it is necessary to attribute a clear meaning to the terms. Therefore scientific satellites are built for the scientific community. Multilateral programmes are carried out with the contribution of space agencies from several countries. Civil applications refer to the programmes that have a direct impact on the public (telecommunications, navigation, etc).

Hereunder is a list of the main missions planned by CNES plus a short description of each one (Table 5).

Table 5: Main CNES missions

category	program name	Description
civil applications	Doris	CNES is behind The DORIS system, which was designed and developed by CNES in collaboration with GRGS and IGN. It <b>has a dual purpose</b> . It is used to determine the orbit of satellites equipped with DORIS receivers with centimetre accuracy using a network of ground stations as reference points on Earth. The system is designed to be used in many satellites including the French-Chinese and French-Indian satellites planned in 2009.
civil applications	Galileo	The European "GPS" started thanks to ESA and CNES studies. Today it is managed by ESA and also funded by the EU. French companies play a very important role as they have complete responsibility for the ground segment and for the platform of the satellites.
earth observation	Demeter	Based on preliminary research and studies by scientists from other countries (i.e. Russia and Italy), the programme is in charge of measuring all the geophysical parameters of the upper atmosphere likely to be affected by telluric or volcanic activity on Earth. In orbit 2004
earth observation	meteosat MSG	France is behind this ESA program. MSG1 and MSG2 have already been launched. Meteosat 3 is planned for 2008 and MSG4 planned for 2012. it deals with meteorology in our regions and covers about 40% of the global earth surface.
earth observation	Pleiades	CNES is the prime contractor of this optical earth observation satellite with metre resolution capability. The ORFEO programme is an agreement with ASI related to the Cosmo Skymed programme. Pleiades 1 is planned to be launched in 2009 while Pleiades 2 in 2010. It serves civil and military customers.
earth observation	SMOS	A programme initiated by CNES and managed by ESA, it has the goal of observing soil moisture in land surfaces and ocean surface salinity on a global scale. Launch planned for 2007.
launchers	Ariane 5	Developed by ESA on a CNES proposal. Total mass at launch: 750 t., max mass in transfer orbit 10 t; max height 57 m; 25 launch successes; 3 failures.
launchers	Vega	It is a small launcher able to place in LEO 1500 kg. It was initiated by ASI and ESA. ASI is the major contributor (about 60%). The prime contractor is ELV, a joint venture between ASI and AVIO (a private company). CNES is responsible for the development of the first stage (P80), Vega will be launched from Kourou.
launchers	Soyuz in Guyana	CNES has initiated together with ESA the programme to launch the Russian launcher Soyuz from Guyana Space Centre. The first launch is planned in late 2008.
launchers	Guyana Space Centre	CNES was the initiator of this initiative. The centre is managed by CNES, ESA and Arianespace. It is Europe's window into space
multilateral programmes	Jason 1 and 2	Joint CNES and NASA mission to monitor the oceans. Jason 1 launched in 2001 and Jason 2 to be launched in 2008

multilateral programmes	Meghatropique	A mission devoted to improving the knowledge of the water cycle's contribution to climate dynamics in the tropical atmosphere. CNES and the Indian Space Research organization are jointly responsible for the mission.
multilateral programmes	cospas-sarsat	Detects and locates vehicles and people in distress as quickly as possible; cooperation programme between France, Russia, USA, Canada and 32 other countries. Next launch in 2006
scientific programmes	COROT	Studies the internal structure of stars and seeks out extra-solar planets around nearby stars; launch planned at end of 2006; it is a multilateral programme, with the participation of many countries and ESA.
scientific programmes	Microscope	The objective of the Microscope satellite, scheduled for launch in 2009, is to test the validity of the equivalence principle using space-based measurements. The challenge is to achieve a degree of precision 100 times greater than any experiment ever performed on Earth. The program was initiated by ONERA (French company) and is developed by Onera, CNES, ESA and others.
scientific programmes	Picard	A programme completely financed by France to investigate the simultaneous measurement of the absolute total and spectral solar irradiance, the diameter and solar shape, and to the Sun's interior. Launch planned in 2009.
security and defence	HELIOS	HELIOS earth observation satellites were initiated by France, and developed jointly with other European countries. Helios 1A, Helios1B, have already been launched in the past. Helios 2A was launched in 2004 and Helios 2B will be launched at the end of 2008. The DGA procurement agency is the programme sponsor and has delegated CNES to be the contracting authority for the space component and for the overall architecture of the Helios system.

## 6. Functional strategies

The following management programmes were devised as part of the development of CNES strategies.

### 6.1 Human resources.

First and foremost, it must be remembered that the agreement drawn up with the French government for 2005 - 10 saw CNES pledge to check the cost of personnel and keep it within the limits of increased production. This led to a further drive to improve the quality of resources and to schemes to retain the best resources.

### 6.1.1 Development program

An innovation drive led to the adoption of a human resource development plan based on four professional categories. Beforehand the only way to climb the ladder was to be promoted to one of the major managerial roles. The four categories are:

- management
- technical expertise
- project management
- administration

These four professional categories have the same importance and the same levels of pay; each of the three levels within the four Directorates includes positions whose duties are outlined in a job description. Employees can be promoted to positions of responsibility within each category, or crossover to a higher position within a different category by following specific career paths. A management code of ethics was also introduced to govern human resource management and dictated that promotion could only be gained if a candidate showed suitable capabilities, including being able to periodically educate and motivate employees. Education, training and motivating personnel must take up no less than 50% of the manager's time. The launch of this project was preceded by ten months of talks with Administrators and Employees Unions, as well as other representatives of the social forces. This development programme enjoyed widespread participation.

### 6.1.2 Compensation program

Personnel evaluation is carried out by the Head of the Subdirectorate, who receives from Project leaders a report on the performance of each person on the project.

Every year, each person has a meeting with his direct superior and the evaluation is drawn up in a standard form that contains:

- objectives of the past year;
- objectives for the next year;
- evaluation of performance related to objectives;
- personal qualities (personal attitude, relation capability, etc).

The form is filled in with the name of the person, the name of the manager, the highlights of the year, the objectives for the past year and the objectives of the next year. It is important to point out that objectives related to personal qualities are also introduced: for example if a person has problems with colleagues, a personal objective related to this aspect will become the objective of the person for the next year. It is not unusual that a very good engineer and designer is not able to communicate with colleagues: in such a case a personal objective is introduced to improve his attitude towards social relationships. Also specific results such as inventions, licences, participation in design reviews are written in the form; there is no area dedicated to identifying the "potential" of the person.

The standard form (mentioned above) is filled out by the direct superior and signed by the person, the direct superior and the second level manager. In case the person does not agree, he/she can write a comment in a comments box on the form to explain why he/she disagrees.

Each Directorate has a commission in charge of evaluating the final results of this process and deciding the compensation and promotion programme. Every year each department or service evaluates all its personnel.

The so-called potential of an employee is not evaluated.

This system for personnel evaluation has been used for many years, so it is a common practice and tradition of CNES and was still operative before the organizational revolution of 2002. Of course this system has had to be adapted to the new organization in order to take into account the restrictions of a matrix.

### 6.1.3 Inventions Policy

The policy concerning intellectual property rights is defined in a procedure that identifies the rules to be adopted when evaluating the compensation of patents. In particular CNES gives money when one of the following conditions comes into play:

- the patent is applied;
- the patent is accepted;
- the patent brings advantage to CNES..

The value of each patent is between 500 and 1000 euro.

CNES pays all the costs of the patent and participation in the project review.

### 6.1.4 High potential people

CNES is not equipped with a formal system to identify, track and cultivate high potential people.

Due to the small number of high potential people (there are about 20 high potential people working for CNES), they are identified following a “cooptation process”, instead of having a formal ad hoc system. During the yearly evaluation, the manager gives an appreciation on the prospective of the person: technical expert, senior, manager or project.

This information is analysed by the Human Resource Directorate which, in this way, has all the information required to spot “high potential” people. This procedure is not formal.

CNES retains that 1 - 2% of its 2000 employees i.e. 20 - 40, are probably high potential. This can be easily managed informally without specific tools. CNES has the following classification of levels: 2, 3A, 3A+, 3B, 3B+, 3C; levels from 2 up to 3B inclusive are evaluated by the Directors, levels 3B+ and 3C are evaluated by the executive committee, COMEX. COMEX includes all the Directors and the CEO.

Beside the levels there is a job mapping system based on the following matrix (Table 6). The blocks identified with X are managed by Comex. This method was introduced together with the new organization.

Table 6: Job matrix system

	Manager	Project	Technical	Adm/finance
level 3	X	X	X	X
level 2	X			
level 1				

### 6.1.5 Education

CNES has a yearly education plan related to technical, scientific and managerial aspects. It runs in-house education courses for management, project management, quality and space technology. Usually the teachers are CNES senior engineers; during the courses external experts are invited to bring and share their experience. CNES has no particular agreement with universities; this is not necessary because many of CNES's experts teach in Universities or in engineering high schools.

### 6.1.6 Selection of personnel

For every vacant position, CNES carries out a selection starting from 20 candidates on average. CNES sometimes advertises in newspapers, but basically the selection is made on the basis of a large portfolio of self candidacies. The candidate has a first interview conducted by Human Resources, who make a first selection, then an interview with engineers or the head of department. Human resources and middle management propose two candidates to the Subdirector; the Subdirector selects one person and presents him to the Director. The final decision is made at Director level.

## 6.2 CNES policy on R&D and relations with CNRS (National centre of scientific research)

As far as R&D is concerned, CNES adopts NASA's Technology Readiness Levels (TRL), which are a systematic metric/measurement system that supports assessments of the maturity of a particular technology and a constant comparison of maturity between different types of technology. The first level encompasses basic activities, while the highest level deals with development. Sometimes CNES conducts R&D with CNRS in astronomy and in the development of new products (e.g. new solar panels) as well as with industry. Although CNES and CNRS do work together, CNES also carries out work in its onsite laboratories. Relations with CNRS mainly cover space and technology. When creating a complete scientific payload, a combined team of CNES and CNRS employees is set up; here CNRS is responsible for scientific performance and CNES for technical performance. CNRS has technical and HW/SW development capabilities, but they are of a scientific nature, e.g. CNRS does not have thermomechanical engineers, electronic component engineers or quality engineers. Consequently, CNRS is not able to build a flying payload. CNES competences therefore complement CNRS competences in such jobs.

One of the main characteristics of CNES is that it can establish the technical specifications for products to be ordered from industry. In this way, CNES promotes both a technology transfer process and a learning process within industrial businesses. CNES also deals with payload technology because CNRS does not have these competences.



### **6.3. Management By Objectives and Management By Processes.**

CNES has introduced Management By Objectives (MBO) and Management By Processes. Introducing the ISO certification, CNES has been described through processes. They have mapped all the processes, identified the process owner and audit and evaluation of the performances on the process. They have processes to manage the company, to implement activities, to perform services, etc.

One of the most important processes is the “Project control”; this process is supported by an internally developed S/W tool for project management: it is a multiaccess system that enables the people involved in a project to interact by inputting data and retrieving information.

MBO is clearly addressed to the managers and is identical to the MBO principle within a private company.

### **6.4 CNES policy during Phase 0 and Phase A**

CNES performs these phases internally. Sometimes CNES needs information on new products or performance and it asks industries, of course without any contractual relation. Companies are not contacted in order to avoid infringing European rules. CNES gives equal chances to all companies. Starting a relationship with a company in the first phases gives a big advantage to this company and does not enable equal opportunities and fair competition to be observed. Once the first phases are completed, CNES issues an open competition. Organizations like CNES have a tool envisaged by law called “competitive dialogue”; this tool is used when CNES has no suitable competences on a specific topic, consequently CNES can ask industries to help them to draft the specifications more clearly. CNES is able in any case to avoid the involvement of companies because they have all the competences in-house. To follow EU rules, CNES is obliged to involve foreign companies for the procurement of S/W packages, services etc. In France there is a “public market code” that is applied to government companies and provides the rules for procurement, but CNES is not a government, but a private company, even though the French state is a shareholder. CNES has to respect the rules of the “Public Market Code” as well as EU directives on fair competition because public funds are being used. In the case of Space systems, CNES may invite French companies only to take part in the competition.

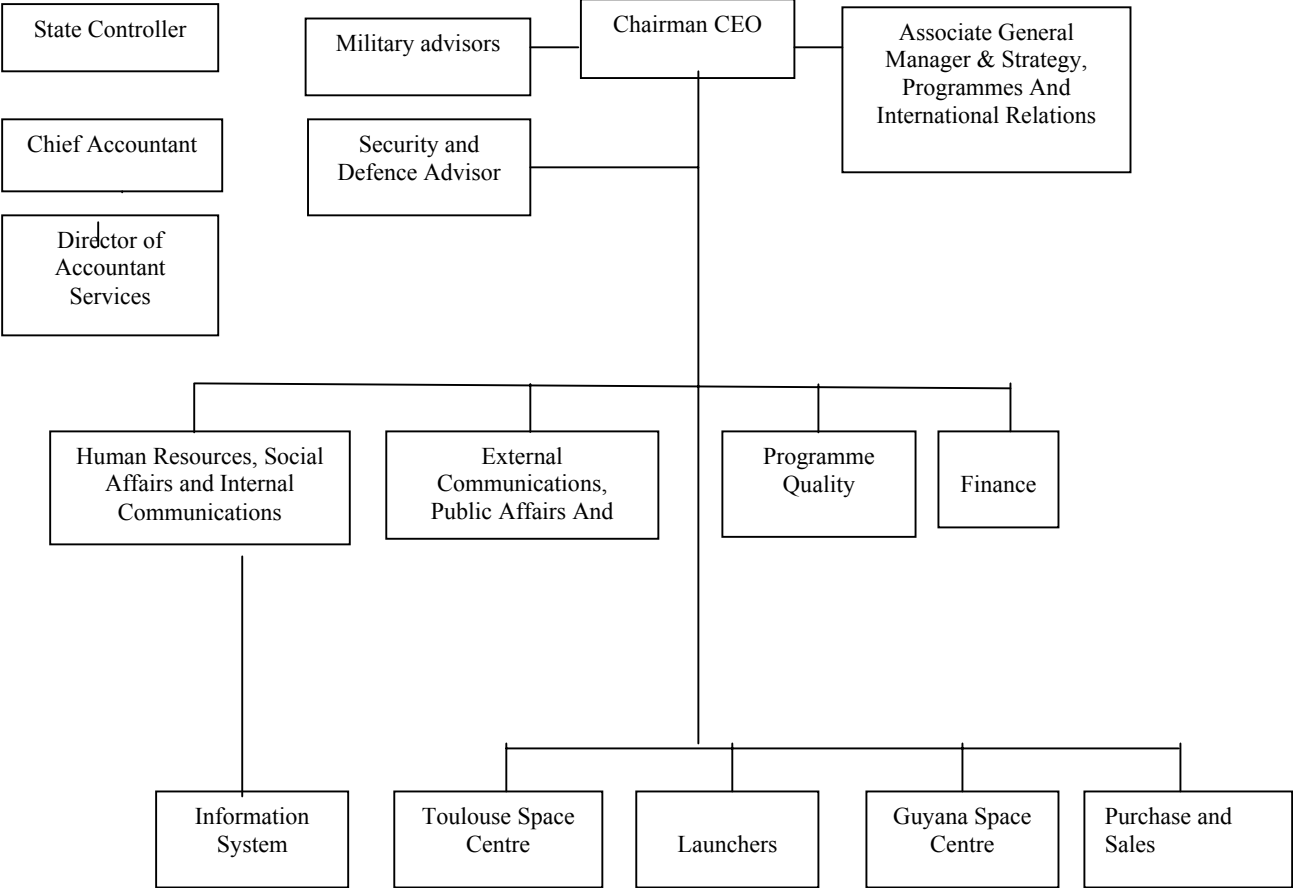
### **6.5 Promotion of space**

The promotion of Space is considered very important by CNES; the responsible of this activity is Mr. Trefouret. This directorate has branches such as "space and young people", "space and teach", and event organization. The following are the main schemes CNES takes part in:

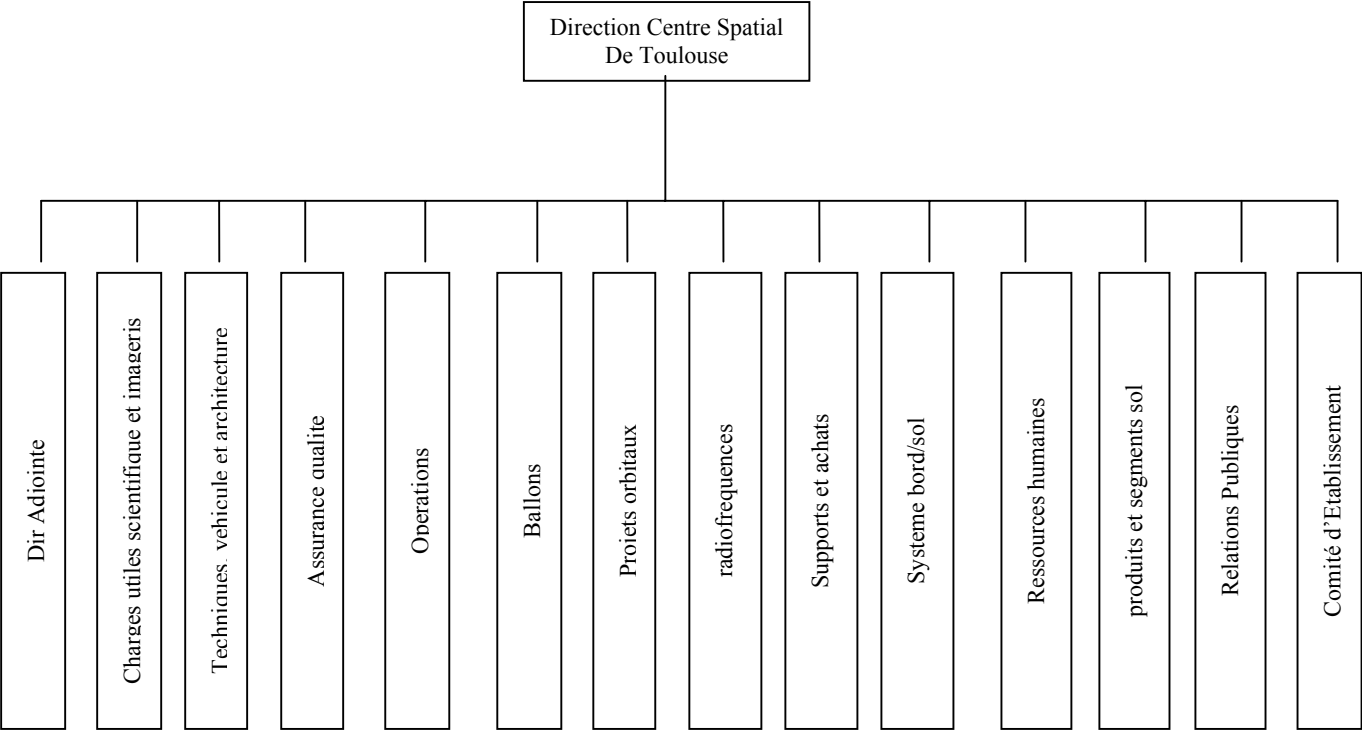
- supporting an association for the education of young people;
- preparing and updating a Space kit for schools. This kit contains text, pictures and movies detailing CNES and CNES programmes. The kit is distributed to all Science and Physics teachers at high schools; this is why thousands of copies are regularly prepared and issued; the kit is updated on a regular basis every two years.
- encouraging its technicians and experts to teach in high schools and at universities. Since CNES has strong ties with Defence, receives a large amount of military funding and is involved in

military programmes, all the promotion activities must take into account the boundaries and the constraints imposed by the French military; the public is not given all the technical details due to restrictions and the information disseminated covers more general than specific technical issues.

Annex 1: The organizational chart of CNES



Annex 2: The official organizational chart of Toulouse



Annex 3: The organizational chart of Toulouse derived from the empirical analysis

