19. The European Transonic Wind Tunnel - ETW

A major result of the work of the DRG Aerotest Group and the AGARD LaWs Group, (see Chapter 27), was the formation of a DRG (Defense Research Group) Project Group which under the Chairmanship of Ir. A.J. Marx, General Director of NLR, developed a technical and organizational plan for a high Reynolds Number transonic[1] wind tunnel.

Although some other nations took part in the Aerotest and LaWs studies, finally only France, Germany, the UK and The Netherlands continued with the plan for a European transonic wind tunnel.

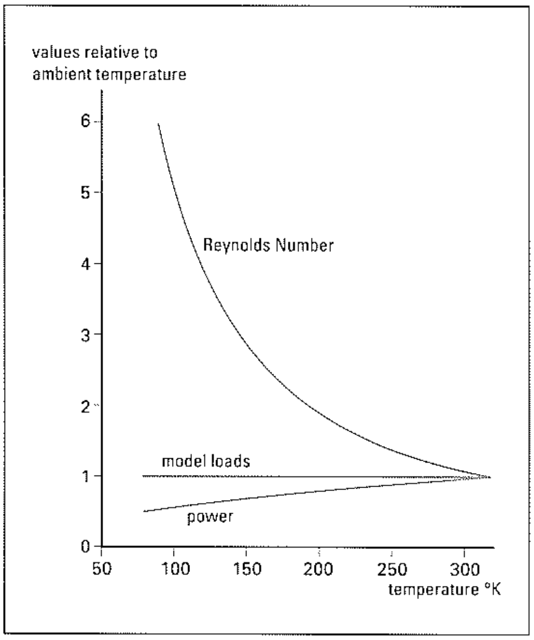
The first problem to be tackled was that of the drive system because for a tunnel of the size and pressure then specified, the power requirements for a conventional tunnel type would be prohibitive. During the period of 1973-1977 four different concepts to drive the test air through the tunnel circuit (the Airline) were developed and in two laboratories in France, one in Germany and one in the UK, pilot facilities were built and tested. These concepts were all based on the requirement that the steady state running time of the tunnel - the effective test time - had to be at least 10 seconds. Out of these investigations came proposals which would result in a facility with much smaller investment and running costs than a wind tunnel of the conventional type, but there was a considerable technical risk in scaling up the pilot facilities and extrapolating the results. The Steering Group for Engineering Studies, chaired by Ir. J.P. Hartzuiker of NLR, contracted - via AGARD - the Canadian Consulting Engineering Firm DSMA to compare the four wind tunnel concepts. The DSMA report, issued in May 1974, showed that these ideas known as:

- the Ludwieg tunnel;
- the Evans clean tunnel;
- the injector driven tunnel;
- the hydraulically driven tunnel,

were of considerable technical interest. Apart from the estimates of the capital investment cost and the operating cost, it was difficult to make a choice based on the limited tests made in the different pilot facilities.

During this period NASA was developing the so-called 'cryogenic concept' and encouraged by the results of a pilot facility at the Langley Laboratory of NASA, the four-nation Technical Project Group ETW decided to include this option in their studies. The 'cryogenic concept' meant that low temperature nitrogen was used as the working gas in the wind tunnel instead of air. The gas dynamic properties of nitrogen are very close to those of air and by operating at a low temperature, close to the liquefaction temperature of nitrogen, 77° Kelvin (-196° Celsius), the same Mach Number is obtained at a lower speed than when operating at room

[1]Why is transonic spelled with one 's' while it would be logical to write, in analogy with sub + sonic = subsonic and super + sonic = supersonic, trans + sonic = transsonic? Von Kármán gives the following explanation in his book 'The Wind and Beyond', [Ref. 32]:
-"I was on the train from Aberdeen to Washington with my friend Hugh Dryden, who had left the Bureau of Standards to become the director of NACA. We talked about the phenomenon and decided that if we invented a word, it had to be something between subsonic and supersonic to indicate that the body travels 'through' the speed of sound and back. We choose 'tran-sonic'. However there was an argument as to whether to spell it with one s or two s's. My choice was one s. Dr. Dryden favored two s's.
'Logically speaking, I agree with you' I said. 'The word requires two s's. But I also agree with the German poet Goethe who said that some logic is desirable, but to be always logical is horrible.'
Dryden laughed, and we agreed on the illogical single s and thus it has remained.
Incidentally, I used this new expression in a report to the US Air Force Center Wright Field. Although we had just made up the word, nobody asked me what it meant. They just accepted transonic as if it had always belonged to the language."-
The Oxford and the Webster dictionaries have accepted the one s, but, curiously the Dutch Van Dale dictionary remains 'logical' and uses two s's.



The Power Requirements and the Reynolds Number for a given size tunnel as a function of the gas temperature

temperature. Also the Reynolds Number in the test section is much higher for the same Mach Number since the density of the gas is higher and the viscosity is lower. The Figure shows how these factors work together.

When applied to a conventional closed circuit wind tunnel it will be smaller in size and/or the power will be much lower for a given Mach Number and Reynolds Number. The operation at low (cryogenic) temperatures does introduce several new complications.

The idea of carrying out aerodynamic testing with a gas different from air and at other than room temperatures was not new. In fact over a period of time various gases and temperatures had been considered and sometimes used to obtain Reynolds Numbers and Mach Numbers which would require larger facilities with more power when operating with air. The operation of a large tunnel with nitrogen at low temperatures did become more feasible when the cryogenic technology became well developed and the design of large-scale nitrogen liquefaction plants and the handling and storage of liquid nitrogen became 'standard' engineering.

The cryogenic concept prevailed over the other four concepts because the technical risk of further developing and scaling up of the other new concepts was judged to take too long and might be too costly. So the final result of the comparative study was to choose the cryogenic nitrogen option and that concluded Phase 1 of the ETW project.

Up till that time the costs of the contributions made to the studies and experiments had been borne by the participants who had proposed the concepts and only an amount of DGL. 0.5 million had been spent for common comparative engineering studies. The following design activities were carried out under a Memorandum of Understanding (MoU) between the governments of France, Germany, The Netherlands and the United Kingdom. It consisted of two phases in which the following major tasks were carried out:

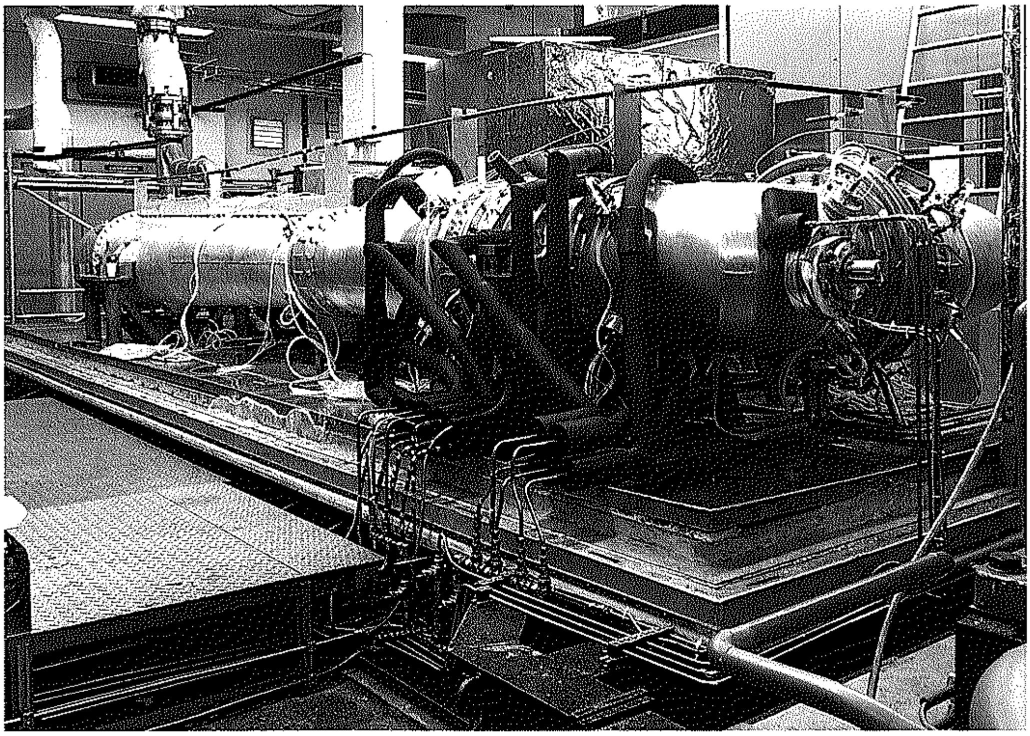
Phase 2.1 : (1978-1985)
- Preliminary Design;
- Design, Construction and Testing of a Pilot Tunnel;
- Development of Cryogenic Techniques for wind tunnel testing;
- Cost Estimates and Division of Costs;
- Choice of Location.

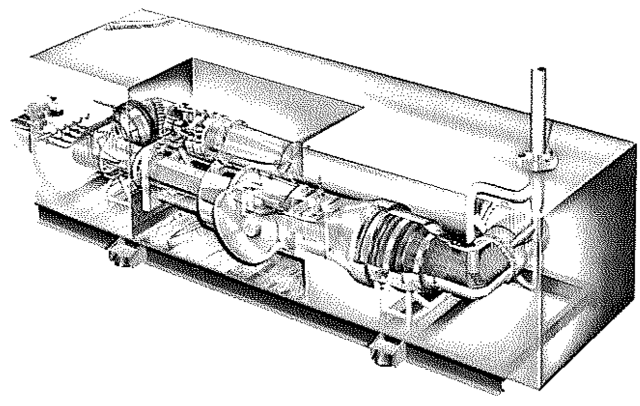
Phase 2.2 : (1985-1988)
- Further Design;
- The Project Organization;
- Preparation of various agreements.

For Phase 2 an international **Technical Project Group ETW** was formed and located at **NLR-Amsterdam**, with Ir. J.P. Hartzuiker as the Project Leader. The Pilot Tunnel (PETW) - located at NLR - was designed by the Canadian Consulting Engineering Firm DSMA, Toronto, Ont. and constructed by various European firms under the supervision of the Technical Project Group ETW. At DLR (then DFVLR), Porz-Wahn near Köln, a model of a large part of the Airline, constructed out of plexiglass for internal flow visualization, was tested in detail. These facilities proved to be extremely useful in developing the wind tunnel.

Various organizations in the member countries started to work on cryogenic techniques as applied to wind tunnels, including instrumentation, force balances and model design and construction. This work was partially funded from the common fund. The total cost of Phase 2 was DGL. 70 million and it included the final engineering design of the ETW which was carried out by the American Firm Sverdrup Technology of Tullahoma, Tenn., USA.

The Pilot Tunnel of the ETW (PETW) under construction at NLR-Amsterdam





Sketch of the PETW, operated for the first time in 1984

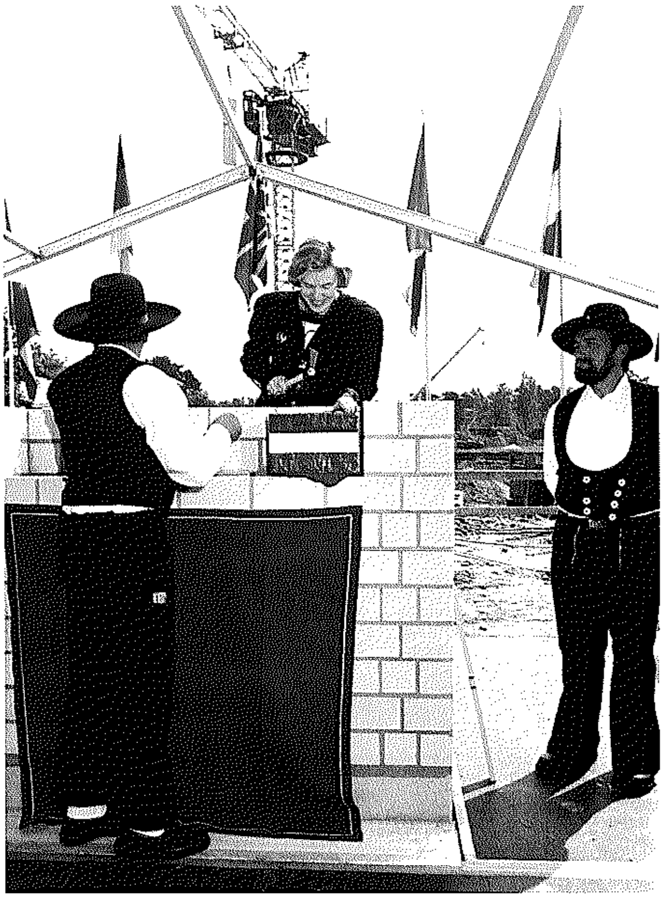
Under the MoU a **Steering Committee** supervised the activities of the Technical Project Group ETW. This Steering Committee was advised by the industry from the participating nations and the AICMA. Of particular importance were the discussions concerning the specifications and the various aspects of operation of the tunnel. Since this tunnel was to be designed from the start to carry out industrial aerodynamic testing only, the involvement of the aircraft industry was mandatory. There were several improvements and changes in the design specifications during this ten-year period of Phase 2 (1978-1988), including a major change from external insulation to internal insulation of the wind tunnel circuit. To a considerable extent the changes were influenced by the views of the prospective users. Although it was not always easy to reach unanimous agreements on all details, the final result was the design of a most advanced and effective facility.

The Steering Committee, with the assistance of Working Groups, prepared a complete plan for the Construction and Operation Phase. A major problem was the choice of the location of the ETW. The sites considered were Le Fouga, near Toulouse (ONERA), Farnborough (RAE), Porz-Wahn (DLR), and the Noordoostpolder (NLR). Like the others, NLR, supported by the local authorities, did its best to make an attractive offer for the location of the ETW. Finally the site of DLR at Porz-Wahn near Köln was chosen.

The Construction Phase 3 started on **28 April 1988** with the signing of an agreement between the governments and the establishment of a company - **European Transonic Windtunnel, GmbH** - owned by the four aerospace research laboratories DLR, NLR, ONERA and RAE (now DRA).

Phase 3 comprised:
(1988-1994)

- Detail Design;
- Construction;
- Commissioning;
- Calibration;
- Initial Operation.



Ministers of the four participating countries each laid a 'Corner Stone' of the ETW on 15 May 1990. Here Mrs. Maij-Weggen, Minister of Transport and Public Works, places a stone with the colors of the Dutch flag

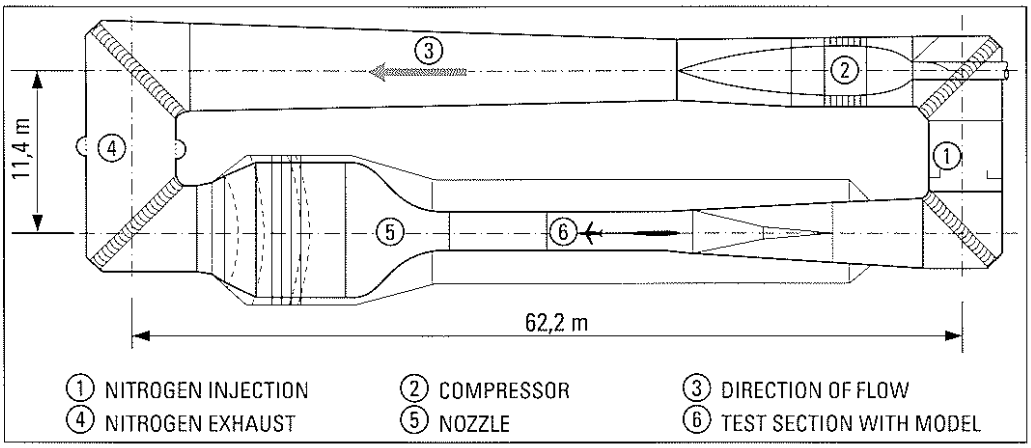
The estimated cost for this Phase 3 was DM. 562 million, (about DM. 600 million after inflation correction in 1993), and including DM. 184 million for the ETW Project Team members and its Advisors. During the previous phases the ETW project team members were seconded from their organizations, but after the company ETW was established it hired its own personnel. Also the services rendered by the owner laboratories were now paid by ETW out of the common fund. The plan is to make the ETW self-supporting after the initial phase of operation, 1994-1997. A reservation of DM. 109 million was made for this period when ETW will build up operational experience and when it will have to prove itself to the customers. In December 1992 the first tunnel runs were made and 8 June 1993 the official opening of the ETW took place. At the time when this book was prepared for publication the ETW project was ahead of schedule and within the estimated costs.

France, Germany and the UK each contributed 31% and The Netherlands contributed 7% to the common fund of the ETW, except for the Construction Phase when Germany contributed 28 + 10 = 38%, France and the UK contributed each 28% and The Netherlands 6%. During the period when the four countries were 'competing' for the site of the ETW it was decided that the country in which the wind tunnel installation would be placed would contribute an extra 10% based on the assumption that in that country economic benefits would accrue from having such an installation on its soil.

Due to the nature of the project - initially very much a development project - the design and construction of the ETW was carried out as an 'owner-managed project' as contrasted with a 'turn-key project'. (In the latter case the owner decides on the specifications and leaves the construction to a firm capable of the realization of the project). It was not unlike the manner in which many other facilities of this type have been realized by national organizations, where the owner has a rather strong project team and is supported by (a group of) consulting engineers.

The ETW Project Team was supported by an international consortium of consulting engineering firms forming the 'Industrial Architect'.

The Airline of the ETW



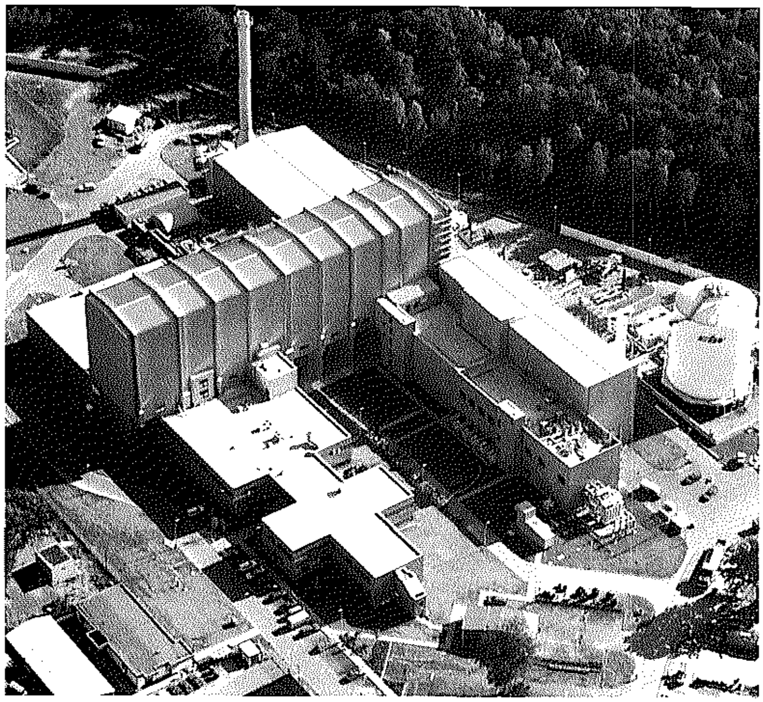
The main specifications of ETW are:

Test Section Dimensions	2.4 x 2.0	M^2
Test Section Pressure Range	1.25 - 4.5	bar
Operating Temperature Range	90 - 313	° Kelvin
Mach Number Range	0.15 - 1.3	
Maximum Reynolds Number	50	million
Fan Drive Power	50	MW
Productivity (typically)	5000	polars[2] per year

During the Construction Phase the Management of the ETW, GmbH, consisted of:

G.L. Harris (UK)	Director General and Chairman of the Management Board
X. Bouis (FR)	*Director Technical and Deputy Director General*
Dr. A. Freytag (GE)	Director Finance and Administration
Ir. G. Offringa (NL)	Director Engineering, Contracts and Construction

Aerial view of the ETW at Porz-Wahn, Köln, 1993



It is clear from the above that the direct financial involvement of NLR in this great international endeavor is relatively small, but during many years the Management and many specialists of NLR devoted a considerable amount of their time to this project. After DNW, this is the second international organization in which NLR participates as an owner organization. Through DNW and ETW the range of operation of NLR was extended and the ties with the sister aerospace laboratories in France, Germany and the UK are strengthened.

[2]A 'polar' is a set of data measured as the aircraft model is rotated through a complete range of angles of attack. It usually contains many data points, all with the same settings of the aircraft model control surfaces and at the same flow conditions.

20. The Innovation Process

NLR is an engineering research laboratory and the research carried out has in most cases a different character compared to the more basic research carried out at universities. But, in spite of the continuous pressure to apply the current knowledge to day-to-day engineering problems, basic contributions have been made by engineers and scientists at NLR.

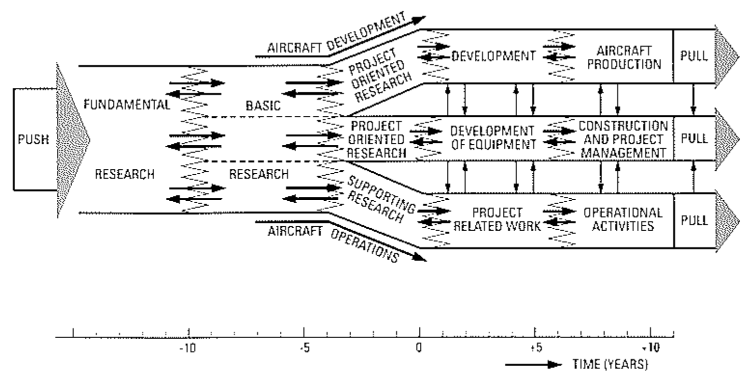
In this book the examples of Von Baumhauer and Koning (flutter), and of Nieuwland (supercritical airfoils) illustrate this point. Another example, of a different nature, is the series of three-dimensional boundary layer basic experiments carried out by Dr. Van den Berg, et al., [Ref. 78 and 79] with an experimental set-up (the 'oblique box' of Van den Berg) whereby the essential features of three-dimensional turbulent boundary layers under pressure gradients of the flow over a wing were studied. This experiment served as an international 'standard' for testing boundary layer calculation methods.

There are of course many examples of this type through which finally useful engineering knowledge is built up. The question arises if these investigations can be placed - often in retrospect - in a generalized scheme.

The Innovation Process

Several years ago Prof. Gerlach published a paper, in which an attempt was made to place the various stages of research and application in a time frame, [Ref. 80]. The model he used is shown in the Figure below[1].

The sequence from Fundamental Research towards Applications



The area on the left - the fundamental research - is typically the domain of the universities; there is often no direct application in sight. In the following domain, here called 'basic research' NLR is quite often active. It is typically the stage in which it is not possible to obtain a contract from a potential user. At NLR this stage is financed, in selected areas, by the annual subsidy received from the Government.

[1]That figure was used for quite some time at presentations by the Management of NLR to visitors. It served to explain the position of the work carried our by NLR in the innovation and development process. Locally this figure became known as the 'drie stromenland' (the three-stream country) or the delta-land and that is also what the Western part of The Netherlands is: a delta-land in North-Western Europe. The metaphor of a delta-land is not inappropriate: the main stream arriving in a delta-land can be influenced very much by what happens upstream, but also in a delta-land there are ways to change the streams but that requires a concerted effort.
The critique on this representation of the innovation process was that it looked too static, but it is of course only a schematic and the time-scale can vary considerably, depending on the subject.

The splitting up into three branches in this Figure indicates that in project-oriented research a possible application is becoming visible. The top branch is oriented towards aircraft and spacecraft development. The middle branch focusses on the development of large test facilities such as wind tunnels, flight simulators, flight test equipment, etc. The branch at the bottom leads towards activities in support of civil and military aircraft and spacecraft operators and also applications for the Civil Aviation Authorities.

Moving towards the right means in most cases that the expenditures rise rapidly and that other, external, means for financing have to be found.

NLR typically operates in the center part of this Figure with the occasional exception of extending towards the left and towards the right. In the case of laboratory installations the activities extend far into the right side of the Figure and in some cases the operational activities also extend further to the right.

The arrow on the left symbolizes the science and technology push and the arrows on the right indicate the pull from the market. The arrows outside the main stream, pointing inward, indicate the inflow of knowledge and experience from outside the laboratory and from activities outside of aerospace. The arrows pointing outward indicate the spin-off of aerospace research to other technical-scientific fields.

The boundaries in the Figure are arbitrary and developments do not always take place in such an orderly fashion but the Figure is nevertheless useful in assessing the stage in which an activity can be categorized.
The time-scale at the bottom of this Figure illustrates that the time from the inception of an idea to the application is often quite long (10-20 years), as illustrated by the examples given in this Chapter.

The above does not prevent the laboratory to start research projects somewhere in the middle, continuing research carried out elsewhere, when necessary and when the capabilities of the staff and the equipment are matched to the task. It is then possible to shorten the R&D cycle considerably when given sufficient resources and priority, but the total time involved when the time period of the work done somewhere else is included, is usually not much shorter.

The Figure is also meant to indicate that what is called here 'basic research' often forms the basis for a wide range of applications. Often research is started with a particular possible application in mind but the major application of the research - if successful - may be quite different.

The important aspects of what is now called 'concurrent engineering' - the concurrent activities of research, development, design preparation for manufacturing, marketing, etc. - are not presented in this Figure.
The Figure only serves to indicate the relation between the various stages. The time-scales may vary considerably from case to case. It is a schematic and reality is often more complicated.

Examples of the R&D Process

The various stages of research of the following examples can be placed in the schematic of the Figure.

Transonic Wing Technology

Starting from the earlier work on transformation methods for two-dimensional airfoils and numerical methods for non-linear differential equations, carried out at universities, the first results - theoretical at NLR and experimental at NPL - were obtained with shock-free transonic airfoils in the 1960's. The story of the NLR contributions leading towards the application of supercritical wings in the 1980's is related in Chapter 9. At NLR it is now considered as a classical model illustrating the R&D process sketched above.

Aircraft Parameter Estimation Method

In Chapter 6 the activities of developing a method of extracting a complete set of performance parameters and stability derivatives from a single aircraft maneuver is mentioned. The basic research of this method - the non-stationary flight test method - was carried out at the Department of Aerospace Engineering of the Technical University Delft under the leadership of Prof. Gerlach. Experiments were carried out with the university laboratory aircraft using a very sensitive inertial platform and gyroscopes.

By using this method it is possible to reduce greatly the number of flight hours to measure the performance of an aircraft, compared to the older methods whereby for each data point a stationary flight condition has to be achieved. The method also yields stability derivatives which cannot be obtained otherwise experimentally from full-scale aircraft. Such data are needed more than in the past, as automatic flight control systems and training simulators are further refined.

In the late 1960's and in the 1970's the method was further developed at NLR and prepared for aircraft prototype testing, using, i.a. the NLR laboratory aircraft and an F28 transport aircraft. Finally the method was applied in the flight test programs of the Fokker 50 and the Fokker 100 aircraft during the period of 1985-1987.

The Development of New Aircraft Materials

A third example, illustrating in particular the long gestation period, is the development and introduction of new aircraft materials such as Carbon Fiber Re-inforced Plastics (CFRP). Several parties are involved in the introduction process: the material manufacturers, the research institutes, the industry providing the processing tools and the equipment, the aircraft manufacturers and the certifying government authorities. Similar developments can be traced for new Aluminum alloys, including Aluminum-Lithium alloys.

The fundamental research at universities and at research laboratories (the RAE in the UK in the case of carbon fibers) started decades ago and the aerospace R&D laboratories and the research departments of the industry have been active for a long time to determine the material properties, including such items as de-lamination, fracture mechanics and crack growth.

In Chapter 8 examples are mentioned of the development of the new aircraft materials ARALL and GLARE by Prof. Dr. Ir. J. Schijve and Prof. Ir. L.B. Vogelesang and their associates at the Department of Aerospace Engineering of the Technical University Delft. At an early stage the industry (Fokker) and NLR became involved in test programs of these composites. The true innovation here came from the Technical University Delft.

Aeronautical Test Facilities

The various stages of conception, research, design and construction in the process of establishing large aeronautical test facilities can also be viewed in the framework of the same Figure. The most recent examples in which NLR was involved are the development of the German-Dutch Wind Tunnel DNW, (Chapter 18), the European Transonic Wind Tunnel ETW (Chapter 19) and also the development of the moving base flight simulators at NLR, (Chapter 6).
In the latter case the Technical University Delft pioneered the development of large hydraulic cylinders (hydraulic motors) for the motion system. Here again it took a period of close to twenty years before this product was fully industrialized. Although the market pull was important, certainly during the last stages, it was a development that had started from the more fundamental technology research push.

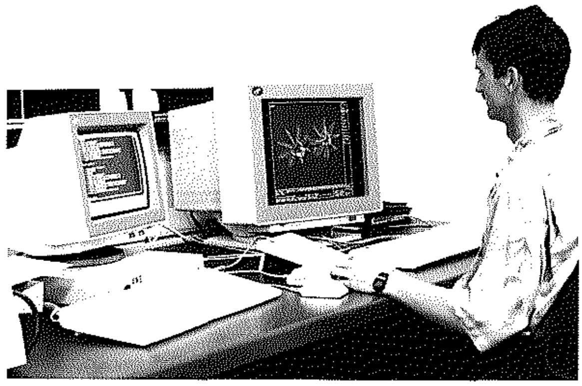
Model design and Model manufacturing

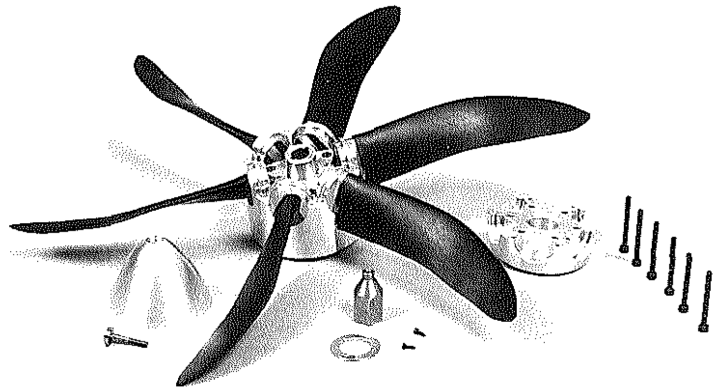
For supporting the research activities of the Divisions, the RSL/NLL/NLR always had available highly qualified Workshops.
As the laboratory was extended over the years, the relative size of the Workshops (model manufacturing, instrument workshop) decreased. The reason was that over the last 25 years of this 75 year period more instrumentation became available commercially and also experience was

built up with a group of companies capable of making high quality wind tunnel models and parts of models. However the NLR Workshops stayed abreast with modern design and manufacturing techniques. It was - and still is - a necessity to maintain a first class in-house capability.

A large-scale Wind Tunnel Model for the DNW, manufactured at NLR

Computer Assisted Design and Computer Assisted Manufacturing (CAD/CAM) of a Propeller for a wind tunnel model at NLR





A Propeller for a wind tunnel model made of Carbon Fiber Re-inforced Plastics

The Characteristics of Aerospace Research at NLR

From these case histories emerges a series of characteristics of aerospace research as carried out by NLR. The NLR is not unique in this respect and similar considerations apply to other aerospace laboratories and, more generally, to engineering research laboratories. These aspects are:

1. Relatively long-time periods

It takes a relatively long time to build up the knowledge, and in most cases specialized equipment is required to make significant contributions. The examples given are now history but there is no indication that, on average, the periods will be shorter in the future. In spite of the fact that new products appear on the market at an increasing rate, the real innovation process does not appear to have become shorter. In aerospace the period between the introduction of new types of aircraft is becoming longer and some state of 'readiness' in new technologies has to be maintained over periods of many years. From a political and economic point of view this is disappointing. If the basic R&D has been carried out it is seldom possible to produce fast (e.g. in a few years) innovative industrial results.

2. Continuity

A consequence of the first characteristic is that continuity in personnel and finances is essential. Specialized knowledge and experience, built up over a period of the order of ten years can be lost in one or two years when a large discontinuity occurs.

3. Highly trained and experienced personnel

A staff of highly skilled personnel is required to carry out aerospace research which is ultimately useful to the aircraft designers, the civil and military aircraft operators, the air traffic controllers, the airworthiness authorities, etc.

An analysis of the specific know-how of the personnel at NLR, carried out in 1984 and reported in an internal paper, [Ref. 81], showed that 55% of the personnel had considerable specific know-how and experience in aerospace which distinguished it from other organizations. To a lesser extent that was also the case for personnel working in the area of instrumentation, computer services and model design and manufacturing. For carrying out its task in the unique aerospace arena, more than half of the personnel must have knowledge of and experience in aerospace.

4. Advanced test installations of significant size and quality

Much of the research related to aircraft and spacecraft is characterized by the use of advanced test installations of significant size and quality: wind tunnels, flight simulators, laboratory aircraft, (super) computers, structures and materials test equipment. For a laboratory that is small compared to those of major 'aerospace nations', it is obviously not possible, nor advisable, to operate facilities of significant size in all areas of interest and therefore a careful selection must be made in the national and international context.

5. Cooperation and exchange of ideas

In the aeronautical sciences there exists a long tradition of exchanging ideas and where possible exchange of results of research on an international scale. In this respect aeronautical sciences are closer to the fundamental sciences than many other engineering sciences. This is related to the fact that aeronautics is by nature not confined to national boundaries and very international. This is an important aspect for any country and definitely for a small country as The Netherlands. Also, the aeronautical sciences matured in a period when international communications grew very rapidly.

The exchange of information and international cooperation become more restricted when commercial applications become feasible.

6. Multi-disciplinary aspects

In aerospace research it is often required to work in multi-disciplinary teams. This means in aerospace: teams of experts in aerodynamics, flight mechanics, performance, propulsion, structures, materials, avionics, etc. The laboratory must on the one hand be organized so that sufficient in-depth knowledge exists in the specializations, but on the other hand it must also be capable of organizing the work in multi-disciplinary project teams to deal with complicated aerospace problems. Finally the 'vehicle' must fly and the work of the specialists must culminate in one reliable transport system.

7. The users character

Many aeronautical research organizations - among which NLR - carry out research for a variety of organizations:

- the aerospace vehicle developers (the industry),
- the operators (the civil and military aircraft users),
- the aeronautical supervising authorities,
- the air traffic control organizations,
- the space organizations,

and also for several non-aerospace organizations whereby the knowledge and experience gained in aerospace research can be applied usefully.

The research is thus carried out in support of aerospace vehicle **development** and **operation**. The ultimate users are in many cases both **civil** and **military** organizations.

While several of these characteristics can also be found in other research organizations, the combination of these four aspects is unique for aerospace research laboratories.
After having attempted to characterize the NLR as it is to-day, one cannot fail to note that this is what Gen. Snijders, Prof. Van Royen and Dr. Wolff envisaged when they began to plan and shape the RSL during the period of 1918-1919.

21. The Structure of the Foundation NLR

The laboratory was started in 1919 as a purely Governmental Service as explained in Chapter 3. The RSL advised government and industry on matters related to aircraft and flying and it carried out theoretical and experimental investigations. The task of the supervision of airworthiness and safety of aeronautical operations in general, which grew out of these activities was formally a separate task.

On 18 November 1929 the task of the supervision of airworthiness and maintenance was given to an Inspector of the Bureau of Aeronautics. This bureau was transformed into the Netherlands Department of Civil Aviation (RLD) in June 1930. For some time the RSL still carried out the supervision of the construction of aircraft and engines and of the more extensive repairs.

As the aeronautical activities expanded and also other Government Departments, besides the Department of Public Works (Waterstaat), the industry, the aircraft operators and others made more and more use of the facilities of the RSL, it was considered desirable to involve those organizations in the planning of the laboratory activities and the general policy to be followed. It was also argued that those interested in the technical-scientific investigations should contribute financially.

These considerations led to the formation, on 14 June 1937, of the private Foundation National Aeronautical Laboratory, **'Stichting Nationaal Luchtvaartlaboratorium, NLL'**. The Foundation was formed by:

- The Minister of Public Works (Waterstaat);
- The Minister of Defense;
- The Minister of the Colonies;
- The Minister of Trade, Industry and Navigation;
- The Minister of Education, Arts and Sciences;
- The Minister of Finance;
- The Society of Aircraft Manufacturers;
- The Royal Dutch Airline, KLM;
- The Royal Dutch-East Indies Airline, KNILM;
- The Royal Netherlands Aeronautical Society, KNVvL.

The task of the Foundation was defined as follows:

1. The management of the National Aeronautical Laboratory with the purpose of: carrying out investigations and to perform tests in the area of aeronautics, to render advisory services in the area of aeronautics and related subjects for governmental organizations or, when requested, for private organizations or individuals, to provide facilities for investigations and tests in this area.
2. The support of the government control of the airworthiness of aeronautical vehicles when requested.

The new organization could operate more freely on the market than a pure government organization and it could receive contributions from private enterprises. The latter was an important part of the income in the beginning. Another reason for starting a non-governmental foundation was that it would, at least in principle, give the Management more freedom in hiring personnel. During the first decades the changes were marginal, mainly because the influence of the Government was still substantial and it was hard to tolerate - certainly during economically difficult periods - that NLL personnel would be enumerated differently from government personnel.

The Board of the Foundation

The first Board consisted of representatives of the founding organizations, but without a representative of the Minister of Finance and with a representative of the Organization for Applied Scientific Research, TNO. The latter organization, created in 1930, covered many areas of applied research for government and industry. Since 1937 there have been several changes in the composition of the Board. During the last 57 years some 130 members served on the Board.

The Board of the Foundation NLR, on 1 January 1994

	Appointed by:
J. van Houwelingen, Chairman	Ministers of Transport and Public Works, of Defense, of Economic Affairs, and of Education and Science
Ir. H.N. Wolleswinkel	Minister of Transport and Public Works, for the Netherlands Department of Civil Aviation (RLD)
Maj.-Gen. Drs. D. Altena	Minister of Defense, for the Royal Netherlands Air Force (RNLAF)
Drs. E.A. van Hoek	Minister of Defense, for the Royal Netherlands Navy (RNLN)
Ir. J.J. Kooijman	Minister of Economic Affairs
Dr. P.A.J. Tindemans	Minister of Education and Science
Dr. R.J. van Duinen	Fokker Royal Netherlands Aircraft Factories
Ir. K.H. Ledeboer	KLM Royal Dutch Airlines
Ir. C.M.N. Belderbos	Netherlands Organization for Applied Scientific Research (TNO)
Drs. G.M.V. van Aardenne	Netherlands Institute for Aerospace Programs (NIVR)
Prof. Dr. Ir. J.L. van Ingen	Delft University of Technology (DUT)
Ms. Prof. Dr. A.J.M. Roobeek	Board of the Foundation NLR
Jhr. Mr. J.W.E. Storm van 's Gravesande	Board of the Foundation NLR

The most important aspect of the change from a government service to a foundation was undoubtedly that the real users of the services of NLL were involved with, and finally responsible for, the long-term policy at the top level. The Board was the body that determined (collectively) the course of the laboratory.

For the Directors and the other Management Team members, the leaders of the technical-scientific divisions, the Board is of direct importance. Annually, towards the end of the year when adjusting the plans for the coming years, they meet with the representatives of the organizations participating in the Foundation: the RLD, the Air Force, the Navy Air Service, Fokker, the NIVR and KLM. It provides the staff of the laboratory with a background to 'calibrate' their ideas about future developments.

At present the Board of NLR meets 5 or 6 times per year. It discusses and approves the annual Work Plan, the Operating Budget, the Investment Budget, the Personnel Plan, Annual Technical and Financial Reports and the more detailed proposals for large investments. The Board also discusses general policy subjects, strategic plans and the international developments. Major re-organizations and appointments of key personnel are also subject to the approval of the Board.

The role of the first three Chairmen

The **first** Chairman of the new Foundation was **Ir. J. Blackstone.** He fulfilled that position from 14 June 1937 to 30 August 1950 when the whole Board resigned, (see also Chapter 5). Ir. Blackstone was employed by the Ministry of Public Works (Waterstaat) and had retired as Director of Public Works in the Netherlands East Indies (now Indonesia). He had been Chairman of the Advisory Committee of the RSL from 1932.[1]
Vice-Admiral A. Vos, appointed by the Minister of Defense, was the first Deputy Chairman. In 1938, when Ir. Blackstone went on a mission to the Netherlands East Indies, he served as Chairman of the Board. It was decided by the Board to locate the Secretariat and the Treasury of the Foundation NLL at TNO in The Hague. It dealt with those administrative matters and finances of the Board which were not directly handled by the laboratory.

The major activities of the Board after mid-1937 were concerned with the transition from a government service to that of a private foundation, including such matters as the creation of a Pension Fund. The personnel was given the choice to resign as civil servants and become employees of the new Foundation NLL or retain their status as civil servant. The large majority chose to resign from the civil service; a few remained civil servants till their retirement. In general the employment conditions remained the same. Gradually small changes were introduced but to this day the general employment conditions are derived from the government personnel regulations, although there is more freedom in setting salaries based on performance and responsibilities compared to the civil service.

An important matter that occupied the Board was the re-location of the laboratory. Although all of this was of course prepared by the Director and his staff, the input, support and full agreement of the Board were very necessary. The construction of the new laboratory in Amsterdam was started in 1939.

The year 1940 was a most difficult year after the occupation in May 1940. The Board held two meetings, on 29 February and on 12 July 1940, before and after the war started. It was decided to institute a Committee of Delegates consisting of:

Ir. J. Blackstone,	Chairman
Dr. Ir. M.H. Damme,	Deputy Chairman
Mr. J.E. van Tijen,	Fokker, till 1941
Mr. G. Spit,	KLM, till 1942, when he was replaced by Mr. H. Veenendaal

During the war period (1940-1945) this was effectively the Board of NLL.

[1] It is amusing now to relate how Ir. Blackstone became Chairman of this Advisory Committee. His predecessor was Prof. Dr. E. van Everdingen, General Director of the Weather Bureau (KNMI) who had taken up this position in 1924 on the condition that the Secretariat should be moved from The Hague to De Bilt, where his office was, and that he should receive a reimbursement of DGL. 400 per year for his secretary. These conditions were accepted but when in 1931 the Minister, in his efforts to reduce the budget, decided that the reimbursement had to be reduced to DGL. 100, Prof. Van Everdingen decided to resign. On 1 January 1932 the Secretariat was moved to the Netherlands Department of Civil Aviation (RLD) and Ir. Blackstone was appointed Chairman of the Advisory Committee. So when he became the first Chairman of the new Foundation he had more than 5 years experience with the laboratory.

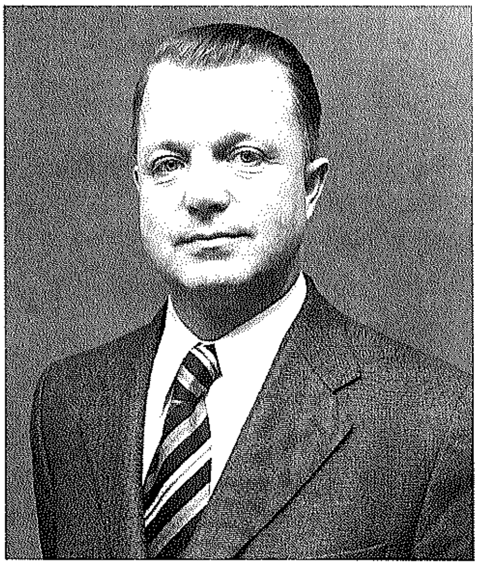
Till 1949 Ir. Blackstone, Dr. Damme (PTT) and Mr. Veenendaal (KLM) effectively formed the Daily Board of the Foundation. Mr. Veenendaal died in 1948 and then Blackstone and Damme were the only two Board members concerned with the daily matters, besides of course the Directors. As reported in Chapter 5, the Chairman and the Board members resigned on 30 August 1950 as a result of the government-imposed work stoppage of the expansion of the laboratory and the order to reduce the personnel drastically.

Ir. Blackstone guided the Board of the new Foundation NLL through its infancy, the Second World War and the beginning of the post war expansion plans. It required apparently a new generation to guide the Board and the laboratory through the following steps.

The **second** Chairman, **Prof. Dr. Ir. H.J. van der Maas**, was appointed on 27 December 1950, a position he held till 7 May 1971. He was 51 years old and extremely well prepared for the difficult task, (see Chapter 29).
The story of the Blackstone-Damme-Van der Maas (BDM) Report to the government, 1950, and the final result that the expansion activities were resumed is related in Chapter 5. Prof. Van der Maas played a very important role in this process of re-starting the modernization of the laboratory and this automatically led to a situation whereby he, as the Chairman, was really a top executive for the laboratory. There were of course other reasons why Prof. Van der Maas took a more executive role during that period. The Director, Ir. C. Koning, became ill and in December 1951 he had to take extended sick leave. He had to undergo surgery, came back for a short time in May 1952, but a second operation was necessary and he passed away on 9 July 1952. He was succeeded by Prof. Dr. C. Zwikker on 1 November 1952. The Deputy Director, Ir. A. Boelen, had a serious motor accident on 17 January 1952 and he could not resume his activities till late in 1953.
During this intermediate period the laboratory management was in the hands of Ir. A.J. Marx and Mrs. M.J.M. Janson-van Wijk.
Ir. Marx was a long-time collaborator of Prof. Van der Maas and they cooperated very closely when the planning and execution of the laboratory expansion was resumed.
As indicated in Chapter 5, a small Board office, including the Secretariat of the Board, was formed to assist Prof. Van der Maas in carrying out his function. (The task of Secretary-Treasurer of the Board which had been carried out by TNO since 1937 was transferred to NLL on 1 January 1948).
It must be remembered that Prof. Van der Maas also held the position of Chairman of the NIVR and that he was very much occupied with developing the Aeronautical Engineering Department of the Technical University Delft, of which he also was Chairman.

Prof. Van der Maas was a very inspiring person and he stimulated with his enthusiasm all who worked with him, directly or indirectly. He knew how to select personnel and he followed their development after they had graduated or worked in his vicinity. He managed to convince Ministers and politicians of the importance of his mission: the development of aeronautical sciences and engineering in The Netherlands in the broadest sense. He regarded his task as a real vocation, a 'calling', and he left a lasting, very positive, impression on technical and non-technical people. He was however not at all an 'Einzelgänger' - one who does it all alone. On the contrary, he consulted many people at all levels and he knew almost everybody who had anything to do with aeronautics on a personal basis. During his term as Chairman, more than 20 years, he led NLL/NLR to maturity and gave it an honorable place on the world map of aerospace research.

The **third** Chairman was **Prof. Dr. Ir. O.H. Gerlach**. He served in this function from 7 May 1971 till 1 October 1991, also a period of more than 20 years. Compared to the time when Prof. Van der Maas took office, many circumstances had changed. The most important aspect was perhaps that the size of the operation of the laboratory had increased and that the combination of three positions as held by Prof. Van der Maas had become physically impossible and also that it was less acceptable to the aeronautical community and the Government. Lt-Gen.(ret.) A.B. Wolff had been appointed Chairman of the NIVR and the Chairmanship (Dean) of the Aeronautical Engineering Department of the Technical University Delft was rotated amongst the professors. The structure of the University was also subject to drastic changes. Prof. Van der Maas was succeeded as Chairman of the Department by his long-time associate Prof. Van der Neut.



Prof. Dr. Ir. O.H. Gerlach

Prof. Gerlach had a background similar to that of Prof. Van der Maas. He had also received a pilot training, while a student at the Aeronautical Engineering Department, and had specialized in stability and control of aerospace vehicles. As an engineer-pilot he contributed greatly to the development of new flight test techniques, (see Chapter 6), flight simulation, pilot modelling and the man-machine interface in aircraft. With this background as a student, assistant and later Professor at the same Department, he was well qualified for the position of Chairman of the Board of NLR. He was fully aware of the necessity to assure continuity in the policy of the Board to allow the laboratory to develop properly within the means available.
When he took office he paid much attention to the external relations, particularly the relations with the Ministers, the Ministries and the Members of Parliament concerned with economics, transportation and defense.

From the beginning he stimulated international relations, which was important for the long term. He had been a member of the AGARD Flight Mechanics Panel and brought with him - through his scientific work - a network of international relations which he used effectively in his new position. He asked the Management of NLR to review the aeronautical activities and plans in other countries and to suggest possibilities for closer cooperation. This resulted in a close cooperation with DFVLR, now DLR, Germany, in carefully selected research topics.
He realized that for effective cooperation it is necessary for both partners to contribute at a comparable level, qualitatively, but if possible also quantitatively. One of the results of this initiative was the DNW, the German-Dutch Wind Tunnel owned and operated jointly by DLR and NLR, (Chapter 18). It also resulted in The Netherlands becoming part of GARTEUR, Group for Aeronautical Research and Technology in Europe, (Chapter 27), an activity which was formalized in a Memorandum of Understanding between France, Germany, the UK and The Netherlands in 1981.

Prof. Gerlach played an important role in managing the cooperation with Indonesia, which became effective in 1980, after exploratory studies carried out from the end of 1979 at the request of Indonesia, (Chapter 28). Here he managed to include not only NLR - mainly for the assistance in the construction and operation of a low speed aerodynamics laboratory in Indonesia, including training of personnel - but also the Aerospace Engineering Department of the Technical University Delft to assist its Indonesian counterpart, the Institute of Technology Bandung, ITB.

Prof. Gerlach continued the line of Prof. Van der Maas in that he followed the progress in the laboratory to the same degree but gradually this changed somewhat as the operation of the laboratory became more complicated and the laboratory became more intensively associated with the development of aircraft at Fokker, (finally resulting in the launching of the Fokker 50 and the Fokker 100), and also because of a multitude of contracts with foreign aeronautical industries and organizations such as ESA, Eurocontrol, USAF, etc.

Prof. Gerlach paid much attention to the general policy of the laboratory in a community of growing international interaction and cooperation. It was also a period in which the style of the Government of The Netherlands changed. Much attention had to be paid to discussions with new members of the Board; there where 44 changes in the membership of the Board during the period of 1971-1991.

During the period when Prof. Gerlach was Chairman of the Board of NLR there were several discussions about the relations between the Foundation NLR and the Government. The tendency of the Government was to loosen the ties between the Foundation and the Government. This seemed to be advantageous to the Foundation in some respects but Prof. Gerlach realized that ultimately Government support to aerospace and particularly to research is essential in the international context in which NLR has to operate. He managed to steer a steady course for NLR through this period of change. The Directors experienced this as a very positive support in managing the laboratory.

A New Period

After Prof. Gerlach retired, Mr. J. van Houwelingen was appointed Chairman of the Board on 1 October 1991. Whereas his three predecessors all had a technical background and particularly Prof. Van der Maas and Prof. Gerlach were aeronautical scientist-engineers, Mr. Van Houwelingen has a political background. He is a Member of Parliament and he was Secretary of State for Defense from 14 September 1981 to 7 November 1989. During these more than eight years he gained considerable international experience, particularly in the cooperation of defense material. He promoted vigorously the 'Independent European Programme Group', (IEPG), the group of European states within NATO in which all European countries of NATO except Iceland (which has no military forces) participate. The IEPG promotes cooperation in the research, development and production of defense equipment.

The appointment of Mr. Van Houwelingen, combined with the fact that the national and international aerospace scene was changing, led him to review the organization at the top when he took office at the end of 1991.
During 1992 a small committee of Board members, assisted by an external advisor, considered the various options and it was decided to transfer the functions and personnel of the Board Office at Delft to the laboratory at Amsterdam, including the consolidated financial administration of the Foundation, the participation in DNW, ETW and GARTEUR, the office of the AGARD National Coordinator and the Secretariat of the Foundation. Thus, after 40 years, this office in Delft was terminated.

Mr. E. Folkers, Secretary of the Directorate, was also appointed Secretary of the Board.
Drs. A. de Graaff, Secretary-Treasurer of the Board till 1 January 1993, became Associate Director with special assignments.

The Chairmen of the Foundation NLL/NLR

16 - 6 -1937	till	30 - 8 -1950	Ir. J. Blackstone
27 -12 -1950	till	7 - 5 -1971	Prof. Dr. Ir. H.J. van der Maas
7 - 5 -1971	till	1 -10 -1991	Prof. Dr. Ir. O.H. Gerlach
1 -10 -1991			Mr. J. van Houwelingen

The Secretariat(*) of the Foundation:

14 - 6 - 1937	till	1 - 1 - 1948	Secretariat of TNO
1 - 1 - 1948	till	4 - 4 - 1951	NLL laboratory
5 - 4 - 1951	till	1 - 9 - 1963	Mr. G.C. Klapwijk
1 -12- 1963	till	1 -12-1964	Mr. P. van der Burgh
1 - 3 - 1965	till	1 - 7 - 1982	Mr. H. Vermeulen
1 - 7 - 1982	till	1 - 1 - 1993	Drs. A. de Graaff
1 - 1 - 1993			Mr. E. Folkers, also Secretary of the Directorate of NLR

(*) During the period 1954 -1993 the function was Secretary-Treasurer

The Directors of RSL/NLL/NLR

(After 1940 the Directorate consisted generally of more than one director. The periods of several directors overlapped)

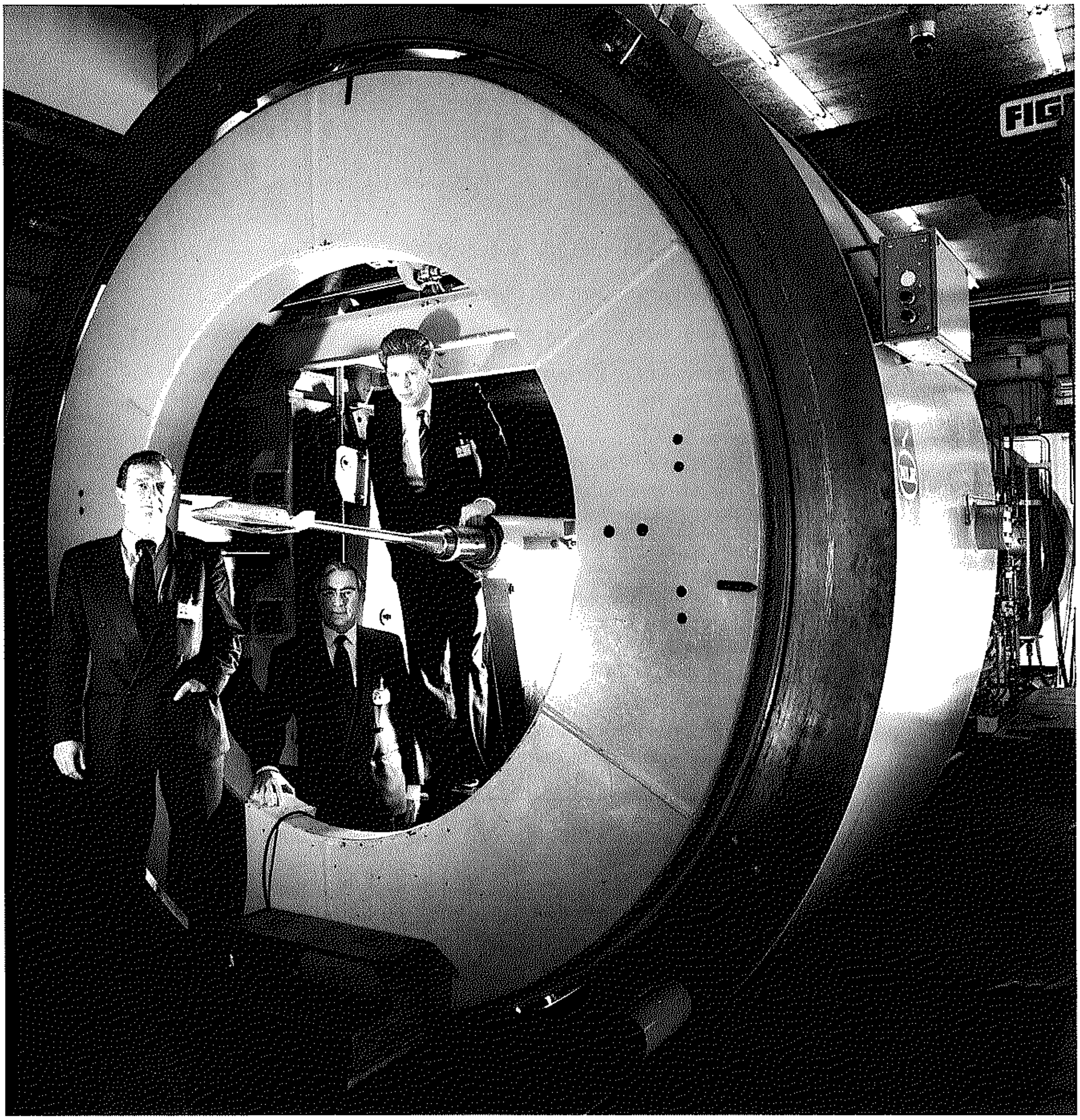
1 - 4 -1918	**till**	**1 - 8 -1940**	**Dr. Ir. E.B. Wolff, Director**
1921	till	1937	Ir. A.G. von Baumhauer, Deputy Director
1 - 8 -1940	**till**	**9 - 7 -1952**	**Ir. C. Koning, (Scientific) Director**

(Ir. A.J. Marx was appointed Chief Engineer in 1947 and in this position he was the Deputy of the Scientific Director till he became Director on 1-11-1956)

1 - 8 -1940	till	1 - 9 -1945	Mr. J.L. Chaillet, Commercial Director
1 - 9 -1945	till	1 - 8 -1950	Jhr. F.C. Beelaerts van Blokland, Commercial Director

1 - 8 -1950 Ir. A. Boelen was appointed Chief Engineer, in charge of commercial affairs while retaining his position of Head of the Aerodynamics Department till he became Deputy Director in 1953. After the re-organization in January 1967 he became Chief of the Technical Services and he retained the personal title of Deputy Director till his retirement in 1974.

1 -11-1952	**till**	**1 -11 -1956**	**Prof. Dr. C. Zwikker, Director**
1 -11-1956	**till**	**1 - 3 -1976**	**Ir. A.J. Marx, Director.** From 1-1-1967 General Director.
1 -10-1957	till	1 - 1 -1976	Mr. J.C. Viveen, R.A., Controller
1 - 1 -1967	till	15 - 4 -1971	Ir. J. Boel, Deputy Director
16 -11-1971	till	1 - 3 -1976	Ir. J.A. van der Bliek, Deputy Director
1 - 1 -1976			Mr. J.A. Verberne, R.A., Controller/ Financial Director
1 - 3 -1976	**till**	**1 - 7 -1988**	**Ir. J.A. van der Bliek, General Director**
1 - 3 -1976	till	1 - 7 -1988	Dr. Ir. B.M. Spee, Deputy Director
1 - 7 -1988			**Dr. Ir. B.M. Spee, General Director**
1 - 7 -1988			Prof. Ir. F.J. Abbink, Deputy Director/ Technical Director



The Board of Directors of NLR in the Supersonic Wind Tunnel of NLR, 1992
From left to right: Dr. Ir. B.M. Spee (General Director), Mr. J.A. Verberne, R.A. (Financial Director), Prof. Ir. F.J. Abbink (Technical Director)

22. Management and Organization

The changes in management and organization over the period of 75 years are enormous, at NLR as everywhere else. The major reasons are the changes in size of the operation - from 10 to 900 employees - and the changes in society. The latter are probably more profound than the mere changes of the extent of the operation.

The organization

When the RSL laboratory started in 1919 two Departments were formed: an Aerodynamics Department and a Materials Department, soon to be followed by an Engine Department. Besides these laboratory departments a more 'General Study Group' was formed to study the aeronautical development, to collect technical data on existing aircraft and to collect and study the literature.

Initially the task of the RSL was to study problems related to aircraft, flying and aeronautics in general and to advise government and industry. During the course of the 1920's this was extended to include the supervision of airworthiness (structural and flight safety aspects). On 1 January 1930 the Netherlands Department of Civil Aviation (Luchtvaartdienst, later named the Rijksluchtvaartdienst, RLD) was formed, which became responsible, i.a., for the airworthiness aspects of aircraft. The RSL was to concentrate on the technical-scientific aspects and also assist this new Civil Aviation Department with technical advice.

Around 1930 the RSL was organized as follows:

- **Management:** Dr. Ir. E.B. Wolff, Director
  Ir. A. G. von Baumhauer, Deputy Director

- **Aircraft Department A:** Ir. S. Wynia, engineer-pilot
  Dr. Ir. H.J. van der Maas, engineer-pilot
  Flight testing and instrumentation

- **Aircraft Department B:** Dr. Ir. A. van der Neut
  Stress calculations of aircraft and parts and drafting design criteria

- **Aerodynamics Department:** Ir. C. Koning
  Theoretical and experimental aerodynamics, including wind tunnel testing

- **Materials Department:** Ir. L.J.G. van Ewijk
  Study of aircraft materials and materials testing

- **Engine Department:** Ing. C. Kuipers
  Study and testing of aircraft engines

At the end of 1930 the total number of employees was 32. Clearly a small number, but nevertheless considering the scale of aeronautics at that time, a very essential group.

In 1937 the NLL was organized as shown below:

- **Director:** Dr. Ir. E.B. Wolff
- **Flight Department:** Dr. Ir. H.J. van der Maas
- **Aerodynamics Department:** Ir. C. Koning
- **Structures Department:** Dr. Ir. A. van der Neut
- **Materials Department:** Dr. Ir. L.J.G. van Ewijk

At the end of 1937, the first year of the new Foundation NLL, but still located at the 'temporary' building at the Navy Yard, the total personnel complement was 59, including 17 university graduated engineers. The Engine Department had been abolished, see Chapter 7.

This organization was maintained from 1937 through the period of the Second World War and it was not till the end of 1946 that changes in the organization were made.

Specifically it was decided to form a department dealing with the theoretical aspects of aerodynamics. The major thrust in aerodynamics at the laboratory was in the area of unsteady aerodynamics and flutter problems, and this new department became known as the 'Flutter Department'. This group did however deal with several other aerodynamic problem areas and it became the 'training ground' for several engineers and scientists who later became university professors in applied mathematics or fluid dynamics.

It was also decided to concentrate all workshop and maintenance activities in one group, the Technical Services.
The need was felt for a separate Electronics Group. Such a group was formed within the Flight Department since that was the department most directly concerned with new electronic applications.

The Administration was also listed as a separate department, it having gained in importance with the expansion of the laboratory and the growing complexity of contracts, personnel matters, etc.

In 1947 the laboratory was organized as indicated below:

- **Management:** Ir. C. Koning, Scientific Director
Jhr. F.C. Beelaerts van Blokland, Commercial Director
Ir. A.J. Marx, Chief Engineer
- **Aerodynamics Department:** Ir. A. de Lathouder
- **Flutter Department (and Theoretical Aerodynamics):** Dr. J.H. Greidanus
- **Materials Department:** Ir. J.H. Palm
- **Structures Department:** Ir. F.J. Plantema
- **Flight Department:** Ir. T. van Oosterom
- **Technical Services:** Ir. J.S. Rotgans
- **Administration:** Ms. M.J.M. van Wijk

At the end of 1947 the total personnel had grown to 225.

As described in Chapter 5, during the following years extensive modernization and expansion plans were made. By mid-1950 these plans were interrupted and stopped till Spring 1952 when funding became available again. This was also the time when the Board in its new composition, under the chairmanship of Prof. Van der Maas, very directly stimulated new activities. The laboratory organization stayed essentially the same during that period.

On 1 July 1953 the following new departments were added:

- **Helicopter Department:** Ir. L.R. Lucassen
- **Free Flight Model Testing Department:** Ir. G.Y. Fokkinga

and later:

- **Combustion Department (1954):** Drs. W.J. Basting
- **Gas Dynamics Department (1955):** Dr.-Ing. S.F.A.H.P. Erdmann

The technical-scientific departments and services reported directly to the Director, Prof. Dr. C. Zwikker. The Deputy Director, Ir. A. Boelen, was responsible for Administration, Technical Services and a new group, Construction Services.

During the 1950's and 1960's several more changes took place. The Structures Department and the Materials Department were merged when Ir. J.H. Palm left NLL in 1950.

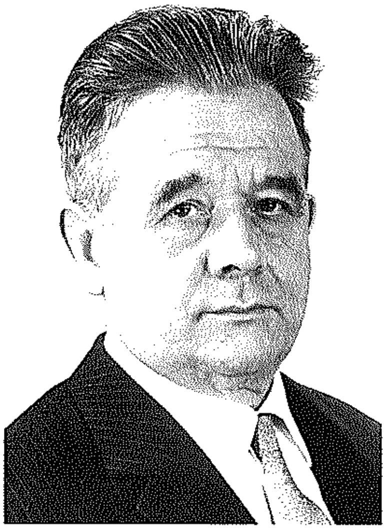
A Transonic Aerodynamics Department, headed by Ir. J. Boel was added and a Mathematical Problems and Numerical Calculation Department was formed under Dr. E. van Spiegel. There were also several detail changes in the Technical Services and of course there were changes in the personnel.

The changes that took place during this period were all related to changes in work load and also due to changes in key personnel which made it efficient to either combine or split groups. However there were no basic changes in the organizational form. The personnel of the laboratory did grow from some 200 to 600 during a period of roughly 20 years (1950 -1970).
The amount of contract research increased impressively as the, initially delayed, expansion of the laboratory was completed. It became an organization of a different scale and complexity. Those developments asked for further adjustments in the organization.

The function of Controller

During 1957 the Board decided to create the function of Controller[1] for the financial-economic management of the laboratory and the Board appointed Mr. J.C. Viveen, a Registered Accountant, R.A., to this position at the end of 1957.
When he came to NLL, Mr. Viveen had ten years of experience with the Central Accounting Service (Centrale Accountants Dienst, CAD) of the Ministry of Finance. It was a new and unique position in the laboratory world. He was serving under the Director, Ir. Marx, but he was also held accountable directly to the Board.
This position actually developed into that of Deputy Director of Finance and Administration in 1967 when a major organizational change took place. The title of Controller was however retained.

[1] In business the name Controller was often associated with a person who checked the expenditures and the finances in general. In the UK the name Controller was also used for the person who controlled (managed) government development programs.



J.C. Viveen, R.A.
1916-1977

Mr. Viveen also developed a great interest in personnel and organizational matters. The Personnel Department was placed under his supervision. During the following years some of the personnel felt that personnel matters should not be entrusted wholly to a person who looked at the operation of the laboratory from a financial point of view. The Enterprise Council, established later, (see Chapter 25) argued that personnel matters - the social aspects - should not be left with the Controller alone. That was of course a valid argument but it was a formal argument since Ir. Marx and later the other Directors were all extensively involved in personnel matters. The Personnel Department was later, at the instigation of the Enterprise Council, organized as a staff function directly under the Directors collectively. But that did not change the fact that many personnel matters are directly related to finances and administration and therefore the involvement of the Controller did not become less important. What is essential is that the Directors collectively balance properly the social, technical-scientific and commercial aspects.
Mr. Viveen was appointed Officier in de Orde van Oranje-Nassau (Officer of the Order of Orange-Nassau). Mr. Viveen had to retire from the laboratory at the end of 1975 because of health reasons.

The Re-organization

When the laboratory operated on a smaller scale all Department Chiefs reported directly to the Director. In the 1960's the span of control became too large. With the assistance of an outside consultant the organization was changed. At its meeting of 21 December 1966 the Board approved a re-organization of the laboratory whereby the Departments were grouped in Divisions and Service Groups.

Ir. Marx, the Director, had been with the laboratory since 1934 and since 1947 he had been Chief Engineer of the whole laboratory till he became Director in 1956. He was well versed in practically all aspects of the operation. The laboratory was growing in size and complexity and Ir. Marx was often called upon personally to participate in national and international organizations. Also the forthcoming retirement of the Chairman, Prof. Van der Maas who was then 66 years old, may have been part of the reasons why at that point in time a re-organization was in order. The Chairman had played a positive but dominant role during the critical period after the Second World War. Clearly a new era had arrived and, with the retention of all that had been achieved, a new form of management had to be found. First the system of one Director was replaced by a General Director with two Deputies, one for technical-scientific affairs and one for financial-administrative matters.
As of the first of January 1967 the Directorate was:

Ir. A.J. Marx	General Director
Ir. J. Boel	Deputy Director
Mr. J.C. Viveen, R.A.	Controller

Following that, the by then numerous Departments, were grouped into Divisions and Service Groups as follows:

Divisions:	◦ Aerodynamics	: Prof. Ir. H. Bergh
	◦ Flight	: Prof. Ir. T. van Oosterom
	◦ Structures and Materials	: Prof. Dr. Ir. J. Schijve
Services:	◦ Technical Services	: Ir. A. Boelen
	◦ Scientific Services (including Space Flight)	: Ir. J. Boel
	◦ Administrative Services (including Personnel)	: Mr. J.C. Viveen, R.A.

During the following years this organization was further developed. On 1 October 1967 the space flight activities were concentrated in a Department in the Scientific Services and on 1 June 1970 this Department became the Space Division, the fourth separate Division.

In all this Ir. J. Boel played an important role. He served in various functions at NLL/NLR, starting as an assistant to Prof. Van der Maas in 1949, and later heading the construction of the HST and the Transonic Department. As Deputy Director he analyzed in great detail the long-term requirements and considered the possibilities and limitations of a relatively small laboratory, in the European and world-wide context. The short- and long-term planning of the program of work and the process of achieving consensus and support in the aerospace community received his attention. The contributions of Ir. Boel in the area of the organization of the research activities are still in effect. His methodical[2] way of working conflicted with the daily management requirements whereby often 'ad-hoc' decisions had to be taken by the Directors (as is to be expected in any business-like operation) and with the views of the Chairman of the Board. This led to his resignation in April 1971. On 16 November 1971 Ir. J.A. van der Bliek, Head of the Space Division, was appointed Deputy Director.

It was also the year when Prof. Van der Maas retired as Chairman and member of the Board of NLR. On 7 May 1971 Prof. Dr. Ir. O.H. Gerlach was appointed as his successor. Prof. Gerlach had been a member of the Board for two years and he had been associated with several technical activities of the laboratory over a long period. He was well prepared for this position, (Chapter 21).

The Directorate was further strengthened during the following years when Ir. D.J. van den Hoek came to NLR from the NIVR on 1 March 1968, first as a technical-scientific staff member and then as General Coordinator directly responsible to the General Director. This function included the preparation and participation in the weekly Directors meetings, the Management Team meetings and various other coordinating activities. Gradually various staff functions which had been distributed over the laboratory became part of the General Coordinator's task. To this were added staff members responsible for Public Relations, Publications, Security, Planning and Procedures and the Coordinators for the various categories of contractors (Chapter 23).

Mr. J.A. Verberne was appointed Assistant-Controller on 16 November 1967, with the first responsibility being that of streamlining the administration, the operating budget and general assistance of the Controller. He succeeded Mr. Viveen as Controller on 1 January 1976.

The function of Secretary of the Directorate - and also the Lawyer of the laboratory - was filled by Mr. P.E. Stolp at the time of the re-organization in 1967. After he left, Mr. E. Folkers joined NLR on 1 June 1972 and carried out the duties of Secretary and Lawyer of the laboratory. When the activities of the Board Office in Delft were transferred to the Directorate at Amsterdam on 1 January 1993, Mr. Folkers also became Secretary of the Board (Chapter 21).

The Management Team

When in 1967 the Departments were grouped into Divisions and Services a Management Team was instituted, consisting of the Directors, the Heads of the Divisions, the Heads of the Services and the General Coordinator. The Management Team meets monthly, dealing with the overall management problems of the laboratory. The agenda contains as standard items the status of the personnel, vacancies approved, the financial status and comparison with the planning, including such items as the evolution of the direct and indirect costs which affect the overhead costs, the status of the investment budget and the progress expected, the development of contract work and the in-house research. The Management Team further deals with all matters concerning the planning and execution of the activities of the laboratory.

The Management Team is an important mechanism for the Directors, the Heads of the Divisions and the Heads of the Services to discuss the status of the laboratory and the future course of action. In turn each Division and Service Head meets after a Management Meeting with his Department Chiefs on subjects concerning their area of responsibility.

The introduction of the Management Team created an additional layer of management but it proved to be more effective than staff meetings of the Director with dozens of supervisors. It is to be noted that in a laboratory of the size of NLR the Departments are relatively small, at least

[2] Ir. Boel often worked late hours at his office, after he had taken up residence in the Noordoostpolder, close to the laboratory site in the NOP. At one time, when he left late, the guard asked: *"Sir, are we having a difficult time with the laboratory since you are working so late?"* Boel explained to him that he was working on long range plans and that satisfied the guard.

compared to industrial organizations of the same size. The lines of communication are still relatively short and generally speaking the organization is 'flat' - it does not have a pronounced hierarchical character.
Management Team meetings are a mechanism to iron out differences of opinion. The Management Team has been instrumental in generating ideas, also in difficult periods. For the Directors it is the body through which it manages the laboratory and through which it obtains its broad support. For the Division Heads and the Heads of Services it is a mechanism for tuning their own activities to the activities in other parts of the laboratory.

The present Organization

The Secretary of the Directorate is also responsible for the Filing Department and Security.

The five Technical-Scientific Divisions are supported by the Technical Services, the General Services and the Administrative Services. The various Central Staff positions, including the Coordinators, Public Relations, Publications, the Personnel Department and the Social Workers are shown in the Organizational Chart on page 188.

The Management of Projects - the Role of the Administration

The five Divisions are grossly discipline oriented and the more than twenty Departments are partially discipline oriented and partially functionally oriented. Many of the research projects do not exactly fit the disciplines treated by the Departments. Much of the work must therefore be carried out in the form of projects with participation of two or more Departments of one or more Divisions.

For many projects then the laboratory operates as a matrix organization, whereby for each project a project leader is assigned. Normally the project leader is a member of the Department in which most of the work will have to carried out. Members of other Departments contribute to the project as required. Although the laboratory operates as a matrix organization there is no Project Department as is often the case in industry. Project leaders for research projects are often experts in their field. Their work may alternate between project work for an outside contractor and their own in-house research projects; generally they remain in their Department and the project is administratively handled through their Department.

It is essential for a research laboratory that many Departments remain **discipline** oriented; it determines the inherent value of a research laboratory. The notion 'discipline' is used here loosely and it includes the operation of complicated laboratory installations such as wind tunnels, flight simulators and laboratory aircraft, which requires skilled operators and people who are well versed in the development of the underlying technical-scientific aspects.

All research is carried out in **'project form'**, that is to say that a project plan is made including a short statement of the work to be performed, a cost estimate and a time plan with milestones when appropriate. After submission of the work plan and the cost estimate, which is checked and completed by the Administration Department, one or more project numbers for the project are assigned to the project.

All man-hours and occupancy hours of the major installations are registered per project number or code number and collected weekly by the Administration Department. With a central computer program the Administration Department then produces financial statements per:

- Project, and sub-projects if required;
- Department;
- Division;
- The complete laboratory;
- Contractor;
- Rolling Budget Contractor.

With this information the Management reviews weekly the financial status of the laboratory, including such items as the development of direct and indirect cost.

Organizational Chart of NLR, 1 January 1994

Technical Director
Prof. Ir. F.J. Abbink

General Director
Dr. Ir. B.M. Spee

Financial Director
J.A. Verberne, R.A.

Associate Director
Drs. A. de Graaff

Head Support Staff — Ing. F.J. Sterk

- **Public Relations** — Ms. J.F. van Esch
- **Publications** — Dr. B.J. Meijer
- **Coord. Defense Projects** — Ir. J.M.A. van den Heuvel
- **Coord. Aircraft Development Projects** — Ing. P. Kluit
- **Coord. Spaceflight Projects** — Drs. J.C. Venema
- **Coord. Aircraft Operations Projects and In-house Research** — Ir. J.A.J. van Engelen
- **Coord. Quality Assurance NLR** — H. Blokker

Secretary
E. Folkers
- Filing
- Security

Coord. AGARD
Ir. L. Sombroek

Coord. Indonesia
J.P. Klok

Personnel
Drs. H. de Heer

Company Social Work
Mrs. M.T.F.J. Simons

Engineering and Technical Services
Ir. G. Brink

- **Technical Projects** — Ir. C.C. Groothoff
- **Technical Design** — A. van den Berg
- **Workshops** — Ir. H.T.J.A. Lafleur

Fluid Dynamics Division
Prof. Ir. J.W. Slooff

- **Aerodynamic Facilities** — Ir. F. Jaarsma, Ir. H.A. Dambrink
- **Experimental Aerodynamics** — Ir. A. Elsenaar
- **Theoretical Aerodynamics** — Dr. B. Oskam
- **Unsteady Aerodynamics & Aeroelasticity** — Prof. Ir. R.J. Zwaan
- **Aeroacoustics** — Dr. H.H. Brouwer

Flight Division
Ir. J.T.M. van Doorn

- **Flight Testing and Safety** — Ing. M.A. Piers
- **Helicopters** — Ir. L.T. Renirie
- **Flight Simulation** — Ir. W.G. Vermeulen
- **Flight Mechanics** — Ir. W.P. de Boer
- **Operations Research** — Ir. G.J. Alders
- **Aircraft Instrumentation** — Ir. R. Krijn
- **Air Traffic Management** — Ir. J. Brüggen
- **Man Machine Integration** — Drs. P.G.A.M. Jorna
- **Transport and Environmental Studies** — Ir. G. Bekebrede

Structures and Materials Division
Dr. Ir. G. Bartelds

- **Loads** — Ir. J.B. de Jonge
- **Structures** — Ir. H.H. Ottens
- **Materials** — Dr. R.J.H. Wanhill
- **Testing Facilities** — Dr. Ir. G. Bartelds

Space Division
Ir. B.J.P. van der Peet

- **Remote Sensing** — Dr. G. van der Burg
- **Systems** — Dr. Ir. H.F.A. Roefs
- **Laboratories and Thermal Control** — Ir. H.A. van Ingen Schenau

Informatics Division
Ir. W. Loeve

- **Electronics** — Ir. H.A.T. Timmers
- **Mathematical Models and Methods** — Dr. R.J.P. Groothuizen
- **Numerical Mathematics and Appl. Programming** — Ir. F.J. Heerema
- **Computing Centre and Systems Programming** — Ir. U. Posthuma de Boer

General Services
Ir. W.F. Wessels

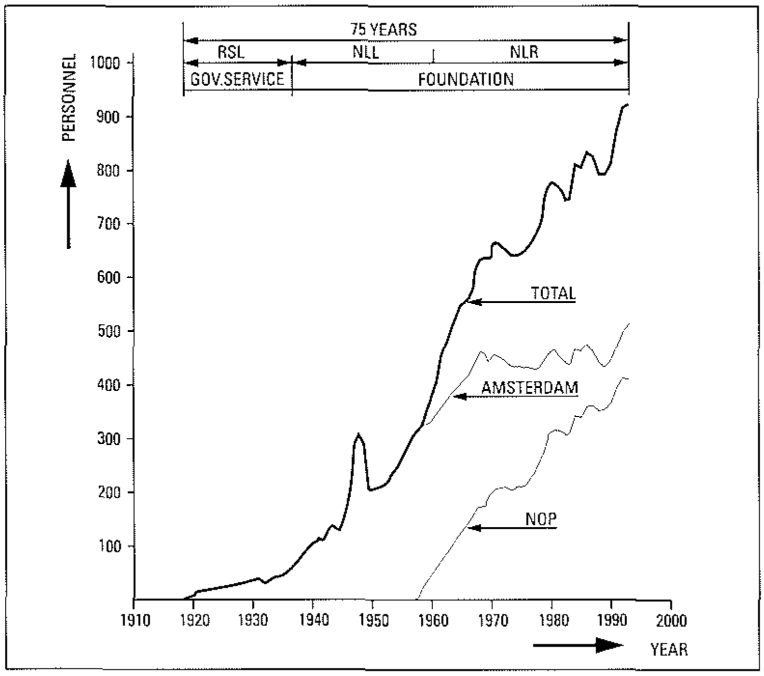
- **Buildings** — Ing. H. van der Roest
- **Power Distribution** — A.M.G. Reijntjens
- **Housekeeping** — G. Lipsius
- **Guarding** — G.M. Zwierink
- **Library and Information Services** — Ir. W.F. Wessels
- **Document Processing** — Ing. D.J. Rozema

Administrative Services
J.A. Verberne, R.A.

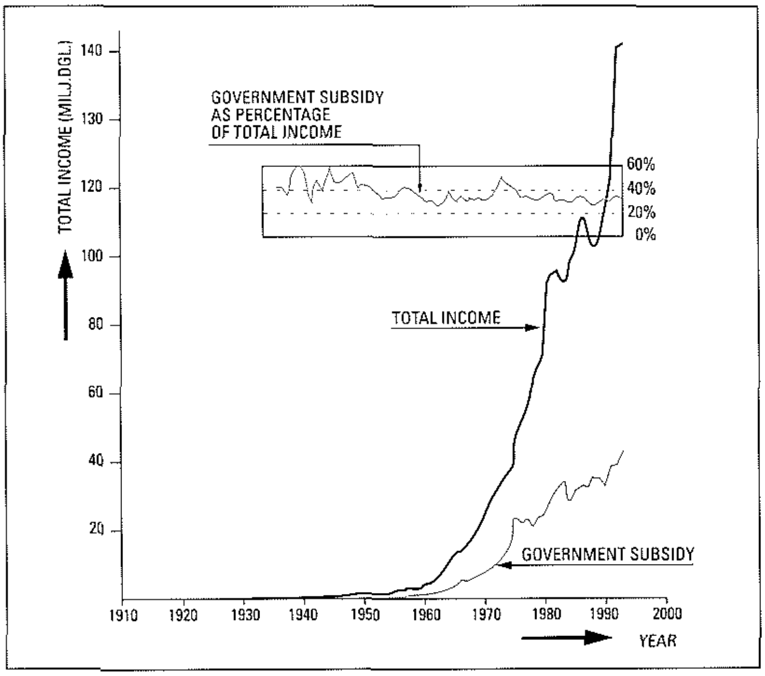
- **Administration** — Drs. B.P.E. Haeck
- **Stores and Transport** — R. Raterink
- **Purchasing** — J.F. Post

Although this type of financial control and project administration is quite common in industry and now also in several laboratories and even at universities, NLR was one of the first to develop a project control and administrative system for a research laboratory. The introduction of this project control system in itself does not make it possible to carry out a variety of research projects for fixed prices. It is also not a guarantee against cost overruns, but it makes it possible to follow carefully the development during the course of the project and to take appropriate measures at the right time. There have been and still are occasionally financial disappointments in carrying out research projects as there are in industrial projects. Due to the nature of research, the undertaking of a task which has not been done before, this will probably always be the case. It is then advisable to proceed in stages and decide on the next stage depending on the technical and financial results achieved at that point in time.

The development of the Personnel over the period 1919-1993



The total Annual Income and the Annual Government Subsidy over the period 1919-1993



23. Planning and Marketing

Several decades ago the notion of planning and marketing of research was considered blasphemous. Even for research laboratories of the larger industrial corporations it was often felt that this was not appropriate since the research laboratories proved their value by coming forward periodically with new ideas and inventions.

Some of the larger, international, companies such as Philips and IBM, did not require specific results - a percentage of the total company income was assigned to the research laboratories in the belief that this investment would result finally in competitive new products as indeed it did. Really fundamental research, and certainly inventions, cannot be planned over the period of time which is considered 'strategic'. Goals and desires can be determined but the final result cannot be predicted.

The RSL/NLL/NLR was of course never set up as a pure research organization; it was meant as a service organization for aeronautics and the activities evolved from the current and perceived future need for research.
It was therefore natural to plan the activities which could be foreseen in some detail while leaving some room for new ideas and initiatives. That was a lofty goal, but as is clear from this history, there was little room for what might be called 'free research'. That is the fate of many other engineering laboratories. The compensation is that - when successful - the personnel is close to real engineering developments and that it derives satisfaction from the fact that the users, and society in general, profit directly from their work.

At a very early stage, in fact from the first day the RSL was established, it was clear that the activities ought to fit into the strategic planning of the country and the aeronautical organizations involved. That was more easily said than done. The strategy was either non-existent or changed very rapidly from year to year, or even shorter. In general terms that was not the case for Fokker or KLM. Their strategy seemed simply to extend the operations and to capture a larger share of the market. To translate those commercial goals into research goals was another matter.

In the 1950's and 1960's, as the country as a whole became more aware of the importance of engineering research and more people with the proper background and mentality became attracted to the aeronautical sciences, the NLL/NLR managed to develop a system of planning and marketing for aerospace research that proved to be very effective.

The question was: Where and how can the results of aerospace research be applied, nationally and internationally? And also: What is the national interest in aerospace research? That was the marketing of aerospace research.
The answer for a small country like The Netherlands was and still is that the need for aerospace research must be based on the following:

- The design, development and manufacture of aerospace vehicles or parts of aerospace vehicles;
- The supply of major (sub)systems of aerospace vehicles;
- Evaluation and acquisition of aircraft and helicopters;
- Acceptance and certification of aircraft and helicopters;
- Operation of aircraft, helicopters and spacecraft, including training aspects;

- Accident/incident investigation;
- Regulatory activities;
- Air Traffic Control on a national basis and the integration in the European ATC-system;
- Activities for international organizations (ICAO, IATA, NATO, IEPG, EC, international development cooperation, etc.);
- Maintenance and repair of aircraft, helicopters and engines;
- Assembly of aerospace vehicles.

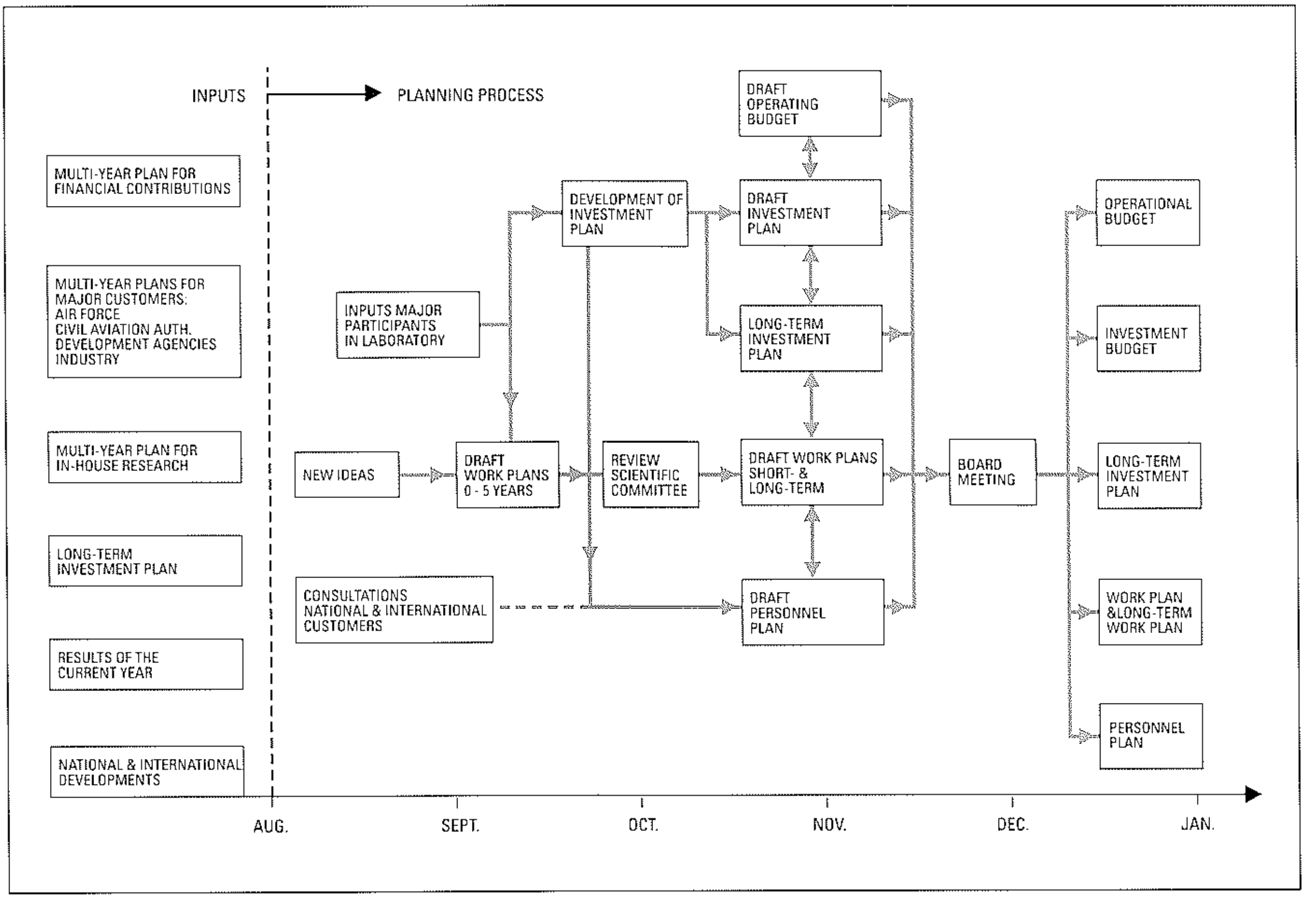
This is an impressive list and it can be extended by a list of applications related to non-aerospace activities which benefit from this research. The latter also includes the laboratory serving as a training ground for scientists and engineers in applied mathematics, applied mechanics, fluid dynamics, the material sciences, systems engineering, etc. Although this was never a goal of the research program of the laboratory it is interesting to note that out of the laboratory came several dozens of university professors who made great contributions to the education at the universities in The Netherlands.

The first item listed above, the design and manufacture of aerospace vehicles - and more specifically the design of aircraft - was the most important driving force for aerospace research in The Netherlands in the post Second World War period, but the other aspects must not be regarded as of secondary or of minor importance if the goal is to make a contribution at an internationally acceptable level in a particular area.

The Planning Process

Schematic of the Annual Planning Process

The elements of the planning process, as it has been practiced for many years, are given in the Figure below. The column at the left lists the inputs for the annual planning process. The first input is the multi-year plan for the financial contributions, mainly the subsidies from the government.



The second item in the Figure relates to the multi-year plans established with several of the major customers/users:

- the Netherlands Department of Civil Aviation, RLD;
- the Royal Netherlands Air Force;
- the Royal Netherlands Navy Air Service;
- the Netherlands Agency for Aerospace Programs-NIVR;
- the industry, mainly Fokker Aircraft and Fokker Space & Systems.

These plans are forecasts for periods of up to five years. Of particular importance are the three multi-year programs of the RLD, the NIVR and the Royal Netherlands Air Force. They are in the form of **Rolling Budgets** and give descriptions of the research planned at NLR - General Research and Project Support Research - and an indication of the funding that is expected to be available for each of the items. The Rolling Budgets are produced by the **Coordinators** (see below), with inputs from the NLR staff and, more importantly, the staff of the customer organizations.

There is also a multi-year plan for in-house research. During each review cycle adjustments have to be made. The long-term investment plan is not only important for its financial implications, but also for the manpower capacity that has to be planned to realize the investments.

The results of the current year, in terms of achievements and use of the financial resources are also a determining factor for the planning of the coming year as are the national and international developments affecting aerospace.

Starting from these inputs the Department Chiefs begin to draw up (or adjust) their plans for the coming year. During this period meetings are organized with at least six of the major customers to obtain their views on current and future developments and their projected need of the services of the laboratory. These meetings are attended by the General Director and Technical Director, the Division Heads of NLR, the Coordinators involved and their technical counterparts of the respective organizations.
Contacts with foreign customers and colleagues, although not organized on such a strict regular basis, are also often very useful in the planning activities.

With this information a Work Plan for the coming years is drafted by the laboratory staff. This activity plan is then discussed and reviewed by the Scientific Committee and its Sub-Committees, (Chapter 24).
After these steps the documents listed below are drafted for the following year:

- the Operating Budget (1 year);
- the Investment Plan (1 year);
- the Long-term Investment Plan (for up to 10 years);
- the Work Plan (1 year) and the Long-term Work Plan (5 years or more) for in-house research;
- the Personnel Plan (capacity needed, 1 year).

At the end of the year this package is submitted to the Board of NLR for their approval. After approval of these documents they form the basis for the activities of the coming year. It is clear that there must be room for deviations from these plans when priorities change during the year for technical and/or financial reasons.

The scale at the bottom of the Figure and the number of boxes give the impression that this is an elaborate process. That is indeed the case but it is also a relatively straight-forward process at least during periods when the long-term goals are clear and well defined. In times of uncertainty these documents are useful instruments to discuss the long-term goals. By carrying out this exercise every year to its full extent the chances of major management surprises are reduced; the actual development of the work during the year can be compared to the base line established by these documents.

Another important aspect of this procedure is that it is a means of making the users/customers aware of the need for long-term planning of their own needs. This is very necessary at NLR where some 70% of the operating income is derived from contract research for national and foreign organizations.

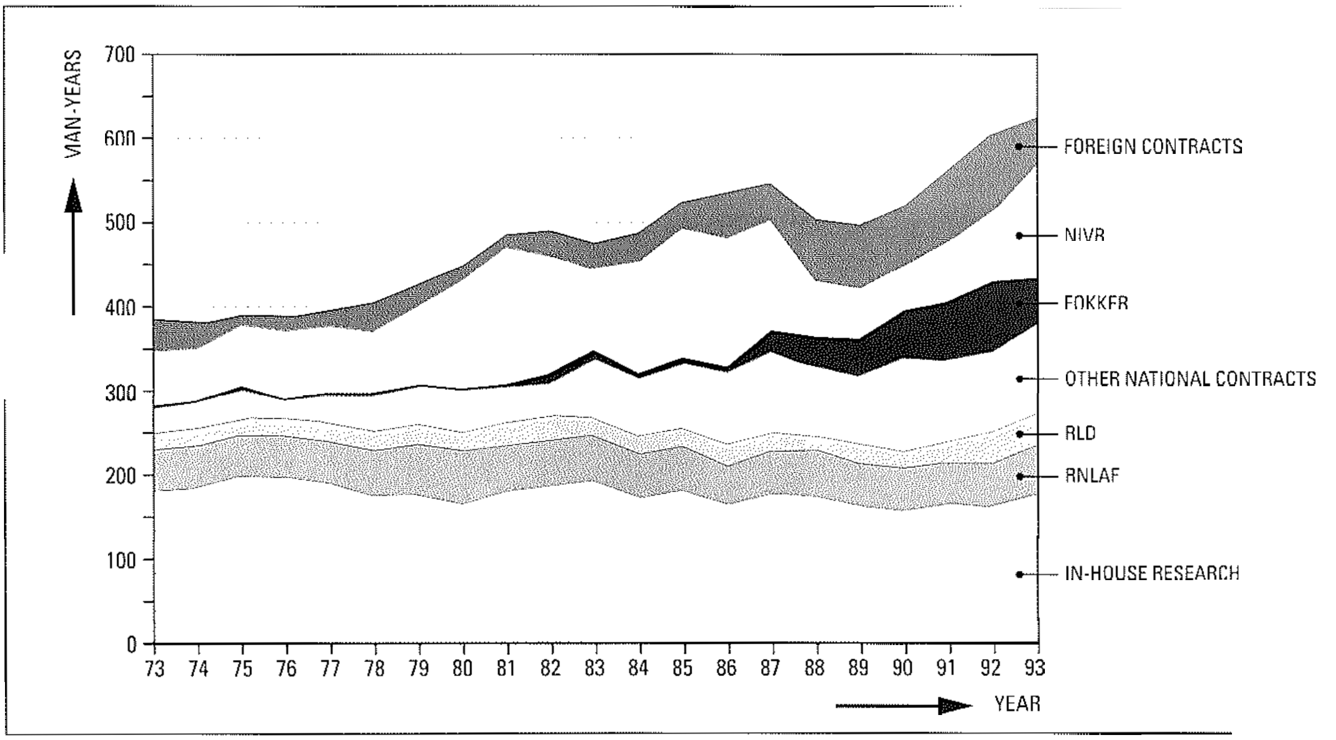
The 'Coordinators'-Acquisition

On several occasions visitors to the laboratory asked the question: *'Where is the marketing and sales staff in your organization diagram ?'*, after they had been exposed to a briefing of the Director in which it was pointed out that a large fraction of the income came from research contracts from national and foreign organizations. The cryptic standard answer was then: *'Every employee is a sales man/woman'*. That was certainly an exaggeration, but since the 1960's the technical-scientific Divisions and the Departments were asked each year to provide a planning for their in-house research showing how their part of the subsidy would be used and how much income they thought could be generated from outside research contracts. They were asked to develop ideas as to how they planned to acquire these contracts and who were their potential customers. This information which served as an input for the manpower capacity and financial planning became more and more important during the last thirty years. The responsibility for acquisition was thus distributed over the Departments which had to develop marketable capabilities and services.

As certain categories of contractors became of interest to more than a few Departments, Central Staff positions for Coordinators were created, starting with a Coordinator for Defense Projects, a Coordinator for Aircraft Development Projects (NIVR, Fokker), a Coordinator for Civil Aircraft Operations (RLD, Eurocontrol) to which were added later a Coordinator for Space Flight and finally a Coordinator for Projects of the European Commission. A Coordinator for the In-house Research Projects - financed by the government subsidy - was also appointed. In 1992 a Coordinator for Quality Control was added to the Central Staff.

The advantage of a staff of Coordinators as described above is that a small group of people is current on the details of the activities planned in the laboratory. By following closely the internal progress and the external developments they are collectively in a position to provide the overall information needed for the Management of the laboratory.

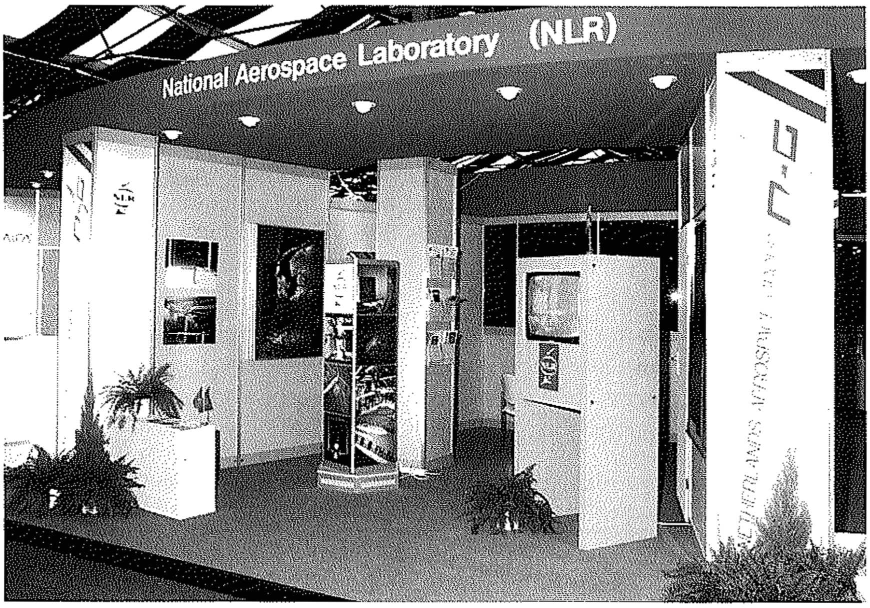
How the NLR-Manpower was applied in the In-house Research and in the various categories of Contract Research



The Coordinators became to some extent marketing specialists and in times of rapid changes in the outside world they were able to provide quickly lists of marketable capabilities and services with which voids in the available capacity could be filled meaningfully. In short: the role of the Coordinators is to maintain contacts with the group of major users (customers), to coordinate the work internally, including the editing of the research proposals and the progress reports of individual contributions, to make the users aware of the present and future capabilities of the laboratory and to assist in the central planning and budget control of contracts.

Public Relations

An activity closely related to Acquisition is Public Relations. For a laboratory this concerns traditionally the publication and distribution of the scientific results. The presentation of papers at national and international conferences, the publication of papers in Journals and the NLR technical-scientific report series is certainly the most important part.
In the 1970's and 1980's 'Flyers,' highlighting specific capabilities, and periodic Newsletters were initiated.



NLR-stand at the bi-annual Farnborough Air Show, 1990

NLR-stand at the bi-annual Paris Air Show, 1993

Participation in international technical shows has also become a very important part of Public Relations. Examples are NLR's periodic participation in shows and technical exhibitions at Paris, Farnborough, Singapore, Jakarta, etc. Often this participation is carried out in close cooperation with other national organizations.
The latter activities developed especially during the 1980's under the guidance of Ms. J.F. van Esch who took up the post of Public Relations Officer in 1980. Public Relations had been initially developed by Mr. A.M. Post, the first employee assigned full-time to this task in the 1970's.

Last but not least: Public Relations also involves presentations to national and foreign visitors and excursions of groups of visitors interested in the aerospace activities of NLR.

H.R.H. Queen Beatrix and H.R.H. Prince Claus

Mr. P. van Vollenhoven

H.R.H. Prince Willem-Alexander

24. The Scientific Committee

During the period 1919-1937 there existed an Advisory Committee for the Government Service RSL. This Committee met 46 times between March 1920 and June 1936. It was instituted at the initiative of Prof. L.A. van Royen, Chairman of the Bureau of Ammunition.

There was considerable discussion on the task of this Committee. Finally it became a kind of supervisory committee to which the Director had to report every month on the progress of the work of the laboratory and the Committee in turn had to report to the Minister of Public Works. The Committee also had to advise the Minister on the Budget Plan submitted by the Director. The members (6-8) were knowledgeable in aeronautical matters and were from the government services, civil and military, and also from the Royal Netherlands Aeronautical Society, the KNVvL. It was a committee reporting on scientific and managerial affairs.
The Chairmen of this Advisory Committee were:

Prof. L.A. van Royen	1920-1924
Prof. Dr. E. van Everdingen	1924-1932
Ir. J. Blackstone	1932-1937

When the Government Service RSL was converted into the private foundation NLL in 1937, an article on the formation of a Scientific Committee was included in the Statutes of the Foundation. This Committee had a different task. The Foundation now had a Board and the Committee was asked to advise the Board and the Director on the Work Plan and during the first years in particular on the plans for the new laboratory. The composition of the Scientific Committee was at the end of 1937:

Prof. Dr. Ir. F.K.Th. van Iterson, Chairman
Prof. Dr. E. van Everdingen
Prof. Dr. W.F. Brandsma
Prof. Dr. J.M. Burgers
Prof. Ir. D. Dresden

As the laboratory grew and some of the research became more specialized it became more difficult to advise in depth on all the activities of the laboratory. Also the NIV (later NIVR) felt the need for independent advice on the proposals for research and the results reported in NLL publications. It was therefore decided in 1955 to institute a what is now called: **The Scientific Committee NLL/NIV**, (later NLR/NIVR).

The Scientific Committee (SC) has as its task to advise the Boards of NLR and/or NIVR on the program of work of the laboratory and give its approval for publication of all technical-scientific publications of the laboratory. The SC consists of five members. It was also decided in 1955 to institute Sub-Committees covering the various disciplines of the laboratory.
Now there are **Sub-Committees** for:

- Aerodynamics;
- Structures and Materials;
- Flight Characteristics and Operations;
- Space Technology;
- Applied Mathematics and Informatics.

The total membership of the Sub-Committees consists of about 50 experts from the universities and the aerospace community, selected on the basis of their personal expertise. Each Sub-Committee meets two or three times per year to review the proposed research program, to monitor the progress and to review critically the unclassified publications (varying between 50 and 150 per year) in the presence of the authors.

The Scientific Committee advises the Board and Management of NLR and NIVR. The SC also occasionally reviews, at the request of NIVR, programs carried out by others and provides advice on aerospace matters in general. The General Director and Technical Director of NLR usually attend all Main Committee and Sub-Committee meetings, and the Division Heads and the Department Chiefs attend 'their' Sub-Committee meetings.

This has developed to be a rather elaborate review system. However a well balanced advisory committee with representatives from the universities (the scientific background), the aircraft and spacecraft industry (the designers and producers), the airlines, the Air Force and the Naval Air Service (the users) and the government agencies (the supervisors and the regulators), is extremely useful for an efficient research program. The members of the SC must of course be prepared and willing to study the research proposals, the intermediate results and the reports and freely comment on them from their professional background and experience. The membership is professionally enhancing for the members. The authors of papers are stimulated knowing they have to defend their work before experts in their field. It is extremely gratifying to note that this system of 'quality control' has been working very satisfactorily over a period of well over 40 years.

The advice of the Scientific Committee plays an important role in the decisions of the Management of NLR and NIVR.

The Chairmen of the Scientific (Main) Committee since its formation in 1937, have been:

Prof. Dr. Ir. F.K.Th. van Iterson	Technical University Delft	1937 - 1950
Prof. Ir. D. Dresden	Technical University Delft	1950 - 1955
Prof. Dr. Ir. W.T. Koiter	Technical University Delft	1955 - 1968
Prof. Dr. C. Zwikker	Technical University Eindhoven	1968 - 1972
Prof. Dr. Ir. A.I. van de Vooren	University Groningen	1972 - 1981
Prof. Dr. Ir. P.J. Zandbergen	University Twente	from 1981

25. Social Developments

During the 75 years of the laboratory the social relations among the personnel changed, the relations between management and personnel changed and the style of management changed. The changes were of course in tune with the changes in society in general. Generally speaking the working relations were far more formal in the 1920's and the 1930's than during the period after the Second World War.

The 'social mobility' - the possibility of moving from one 'class' to another - was well advanced in The Netherlands compared to some of the other European countries and certainly in science and engineering. This did not mean that the differences between the categories of personnel could be neglected. What may now be considered an anecdote is that Ir. R.A. van Sandick, reporting on the festivities on the occasion of the 10th Anniversary of the RSL in April 1929, [Ref. 14], stated at the end of his report that the Deputy Director Ir. Von Baumhauer presented a gavel, made of one piece of wood, to the Director on behalf of the engineers, thanking him for guiding the laboratory through a difficult period. It was in the difficult times that the collaborators of Dr. Wolff had learned to admire him. And then at the end of his report Ir. Van Sandick stated: Finally the 'other personnel' offered the Director an expression of their appreciation. That is how it was reported.

The Personnel Association NLR

On 1 May 1939 the 'Personnel Association NLL' was formed. The total personnel was then about 80. The membership of that Association has always been a high percentage of the total personnel. There are good reasons for this. The Association managed to offer a wide spectrum of activities and advantages for its members. Particularly during the 1940's and into the 1950's this Association was a very important element in establishing social contacts among the personnel. It drew the people together during the war period when outside social activities finally came to a complete stop. Thereafter the character of the activities changed as society in general became more mobile and many more competing outside attractions developed.

A typical lunch during the Second World War: soup prepared by one of the Staff members

The Association is very active in organizing activities both for smaller groups and for the entire personnel. Most spectacular are the Lustrum events which the Personnel Association organizes every five years. Then, periodically NLR organizes 'Open House'-days for the personnel and their families. These are very popular and the Personnel Association, in cooperation with the General Services and Public Relations, plays a very active role in these events. (See pages 205 - 207)

The Personnel Association NLR participates in the 'Coup Raumschub', a soccer competition started by the German sister organizations of the various laboratories of DLR. It also participates in the Ariane Cross races, organized annually by one of the companies participating in the Ariane-launchers program.

NLR-participants of the Ariane Cross, Turin-Italy, 1989

The Personnel Association managed to change with the times and it still has a membership of about 85% of the personnel.

Personnel Representation

Of a different character is the dialogue between the Management and representatives of the personnel. The first event introducing a more formalized representation of the interests of the personnel took place in March 1943 when a 'Contact Committee' was formed to serve as a link between the Director and the personnel. The members of this Committee were elected by and from the personnel. The need for this Committee was obviously inspired by outside events - it was during the middle of the Second World War and there were many issues requiring an extensive dialogue among all of the personnel. This Committee also played a role during the difficult period of 1949-1952 when the personnel had to be reduced drastically.

Although one cannot doubt that individuals, not being part of the Management, had an influence on the major decisions (that has always been the case), this type of personnel representation cannot be compared to the present situation of fifty years later.

The Enterprise Council (Ondernemingsraad)

Since about 1970 every organization in The Netherlands employing more than 50 (originally 100) persons must have a Council consisting of elected employees representing the personnel. It is called 'Ondernemingsraad', literally translated: Enterprise Council. There are similar institutions in other countries; the Enterprise Council resembles the 'Betriebsrat' in Germany. In 1972 the first Enterprise Council was elected by the personnel.

There is one Council for both laboratory sites - initially 9 members from Amsterdam and 4 members from the NOP and now, due to the shift in personnel distribution, 7 members from Amsterdam and 6 from the NOP.

At the start the three categories of personnel (university graduates, technical college graduates and 'others') were represented in proportion of their fraction of the personnel. This system has been abandoned and members are now elected according to the number of votes they receive. Members were elected for a term of two years until 1992; from then: three years.

In 1979 the Law on Enterprise Councils was changed. Till that time the Director of an enterprise was Chairman of the Council. In 1979 this was changed and the Council is now independent and elects its Chairman from its members. The Council meets separately and reports to the personnel.

The Council meets with the Directors six times per year and at NLR the chairmanship during those combined meetings alternates between the General Director and the Chairman of the Council. Without listing the Council's legal duties here, the following selection of items - many of these introduced or strongly supported by the Council - gives an impression of the activities of the Council. The list is illustrative of the influence of the Council on the general working conditions at NLR and on the total operation:

- The salary system, the scales and the application of the system;
- The performance review system;
- Overtime regulations, compensations, irregular assignments;
- Temporary staff contracts;
- Interpretation of the WAGGS (a law regulating the labor relations for government subsidized organizations);
- The distribution of the workload among the personnel;
- Flexible working hours;
- Registration of arrival and departure times/the use of time clocks;
- Procedures for transfer of personnel between departments;
- Re-location regulations;
- Detachment regulations for groups of personnel (working in other countries for extended periods);
- Housing of personnel, offices, work stations;
- Aspects of health, safety and well-being;
- Medical care, selection of the insurance company;
- Training and educational facilities;
- Procedures for handling complaints;
- The aging employee;
- Work consultation at the local level;
- Employment of a Social Worker;
- Changes in the organization;
- Advice on senior management appointments.

The second Enterprise Council in session, 1975

The discussions of many of these subjects were instigated by the Council. Although not all the initiatives came from the Council, it was involved in all cases related to the working conditions. The Management is obliged to seek the consent of the Council when introducing changes in the working conditions or regulations such as the remuneration system, leave, general salary changes, etc. Organizational changes are also submitted to the Council for comments and before the Board of NLR appoints a new Director, the proposal is submitted to the Council for advice.

Pensions, including managing a collective contract with an insurance company, is handled by a separate **Foundation Pension Fund NLR** (which has its own Board), and so the Enterprise Council has only limited dealings with pension matters.

The personnel rules and regulations are formulated and implemented by the **Personnel Department**, which is part of the **Central Staff**. The Personnel Department reports to the Directors and not to the Council. The Council therefore has in most cases an advisory role. It is however the only body within the organization consisting of elected members of the personnel and it is expected to represent the opinion of the personnel. In most cases this is indeed the case and thus the Council is an important body for the Directors to obtain a balanced view of the personnel on current issues.

The Board of NLR and the Directors have their own responsibilities and the suggestions of the Council are not always accommodated. The dialogue does not always lead to solutions that are satisfactory for all parties involved but, with a few exceptions, the system has contributed very much to the evolution of a well balanced Management-Personnel relationship.

The Council receives each year copies of the Work Plan, the Operating Budget, the Personnel Plan, the Investment Budget and the Annual Reports. Discussions of these documents take place in the presence of the Chairman of the Board.

Generally NLR uses the Government Personnel Rules and Regulations as a guide. It deviates when that is efficient for the operation of the laboratory within the legal limitations. In practice that leaves many details to be handled at the laboratory level, particularly since NLR operates more as a business organization than as a government service. The degree of Union membership at the laboratory is very low and the Enterprise Council offers an effective channel for the personnel to engage in discussions with the Management, apart from the hierarchical route.

The employees are in general strongly motivated and highly interested in their work and thus they really have the same interest in the laboratory as the Management. That sounds idealistic but fortunately in laboratory work, particularly in aerospace, that is true. The Enterprise Council is well informed and often advances ideas which are useful to the Management. Conversely the Management needs the opinion and support of the Council for carrying out the business effectively. An example of the positive contributions of the Council in the area of management support was the support received when NLR lost a large amount of contract work overnight when the MDF-100 project was canceled in February 1982. With the assistance of all concerned and with the positive contributions of the Council it was possible to overcome this problem without forced lay-offs.

It took several years for the Management and the Enterprise Council to learn to appreciate each other's possibilities and limitations but now - after more than twenty years of experience - the overall view of all concerned is very positive.

Since 1993 - when the Statutes of the Foundation NLR were modified - one of the Members of the Board is appointed at the nomination of the Enterprise Council.

Social Worker

At the suggestion of the Enterprise Council the laboratory engaged a Social Worker and from 1 November 1976 Mrs. M.Th.F.J. Simons was appointed in that position for the personnel in the laboratories in Amsterdam and the NOP. In 1993 Mrs. T. Diekema was appointed specifically for the personnel in the NOP. The task of the Social Workers is to assist individual personnel members with problems encountered in carrying out their task, either related to their particular work situation or to their personal situation. Although the 'effectiveness' of this social work cannot be measured easily, it has been observed that with this service to the personnel many personal situations have been improved through the assistance of the Social Workers.

Anniversaries and Celebrations

The **10th Anniversary** of the laboratory, (then RSL), was commemorated on 5 April 1929 by an official reception of the various dignitaries at the Navy Yard in Amsterdam and speeches by the Minister of Public Works, Dr. Wolff and Prof. Van Royen, see Chapter 2, [Ref. 14].

On the occasion of the **25th Anniversary** of the laboratory, (then NLL), on 5 April 1944 there was only a small gathering of close associates. This was during the Second World War and there was not much to celebrate. The personnel presented the Foundation NLL with a bench, made by the Woodworking shop. This bench was placed in the entrance hall where it remained till 1991.

In 1969 the **50th Anniversary** of the laboratory, (then NLR), was celebrated on a grand scale. Her Royal Highness Queen Juliana attended the official celebration on 17 April 1969 in the NOP.

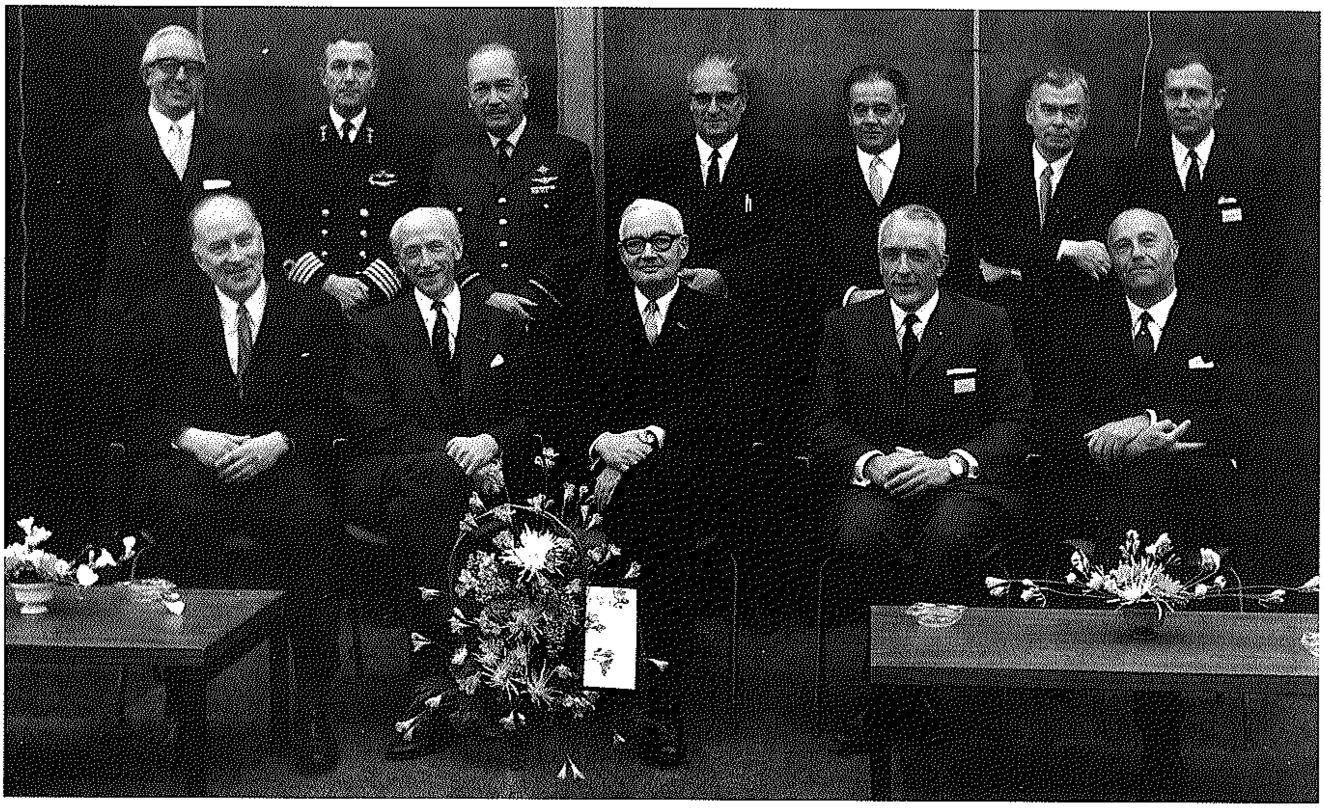
H.R.H. Queen Juliana, arriving by helicopter to attend the 50th Anniversary Celebration of NLR at the Noordoostpolder, is greeted by the Chairman Prof. Van der Maas and the Director Ir. Marx, 17 April 1969

H.R.H. Queen Juliana listening to Prof. Van der Maas' welcome adress. At her right: Ir. Marx

An extensive exhibition was set up in tents in the NOP and during the following two days there was an 'Open House' for the personnel and their families and friends. This exhibition was then moved to Amsterdam where during the following week also a two day 'Open House' was held.

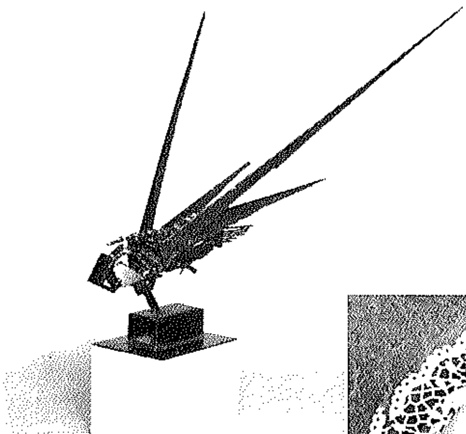
A festive lunch was held for the entire NLR-personnel on the occasion af the 50th Anniversary

An extensive lunch was served for the personnel in the RAI building complex in Amsterdam and all the employees received a great birthday cake and a 'Leerdam' plaque commemorating half a century of aerospace research. This, combined with many congratulatory gestures of the external relations and the cabaret performance organized by the Personnel Association made it an unforgettable celebration.

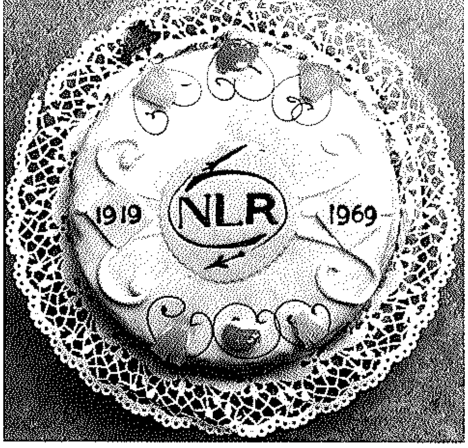


The Board of NLR and the Directors at the 50th Anniversary Celebration
From left to right: (front row) Mr. W. Stadermann (Min. of Traffic and Public Works), Lt-Gen. H. Schaper (KNVvL), Prof. Dr. Ir. H.J. van der Maas (Chairman NLR), Ir. A.J. Marx (General Director NLR), Mr. H. Reinoud (PTT) (second row) Drs. Th.A.M. Thomassen (Min. of Finance), KTZ. A.H.D. Hoppener (RNLN), Maj.-Gen. G.W. de Zwaan (RNLAF), Dr. J.H. Greidanus (Fokker), Mr. J.C. Viveen, R.A. (Controller NLR), Dr. H.H. Mooij (TNO), Ir. J. Boel (Deputy Director NLR)
Not present: Mr. G.W. van Hasselt (KLM) and Drs. H.P. Jongsma (Min. of Economic Affairs)

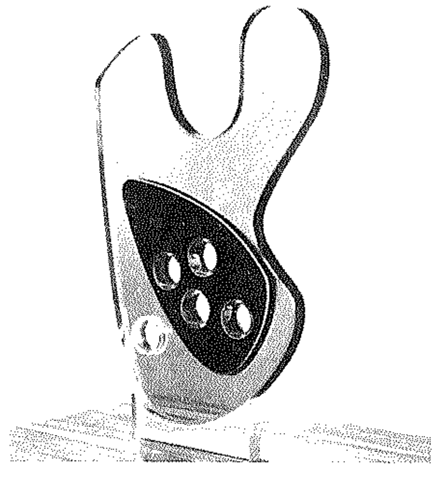
A 'Leerdam' glass plaque commemorating the event, was presented to the personnel



'The Wasp', a steel Sculpture presented by the Personnel Association to the Management of NLR



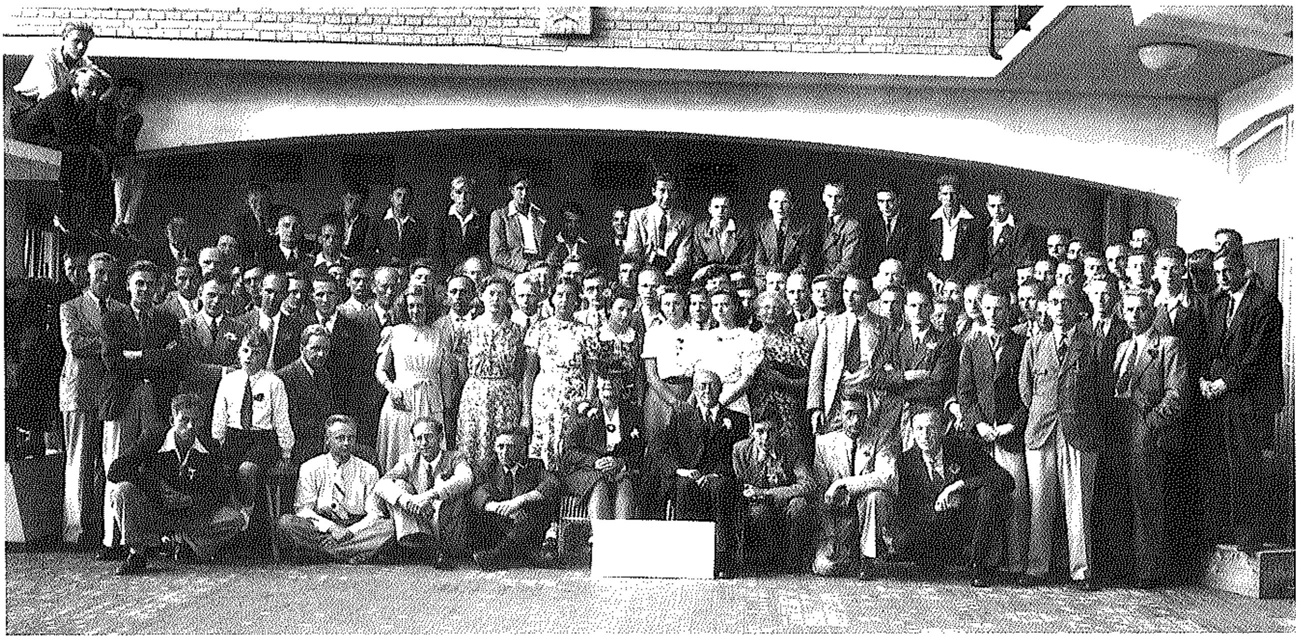
All of the personnel received a Birthday Cake at home



A glass Sculpture presented by the Personnel Association to the Management of NLR

Personnel Anniversary Celebrations

Up till about 1970 most Departments organized a celebration when someone was employed for $12^1/_2$ years. Often this was the occasion to play a joke on the 'victim'. He was received by his fellow workers and was asked, or even forced, to perform some impossible task. It was the occasion for his colleagues to express their feelings about him, usually in a good-natured manner. Later this custom faded away.



Celebration on 2 August 1943 of the 25th Anniversary of Mr. M. Pinke joining the laboratory.
He was one of the first employees of the RSL

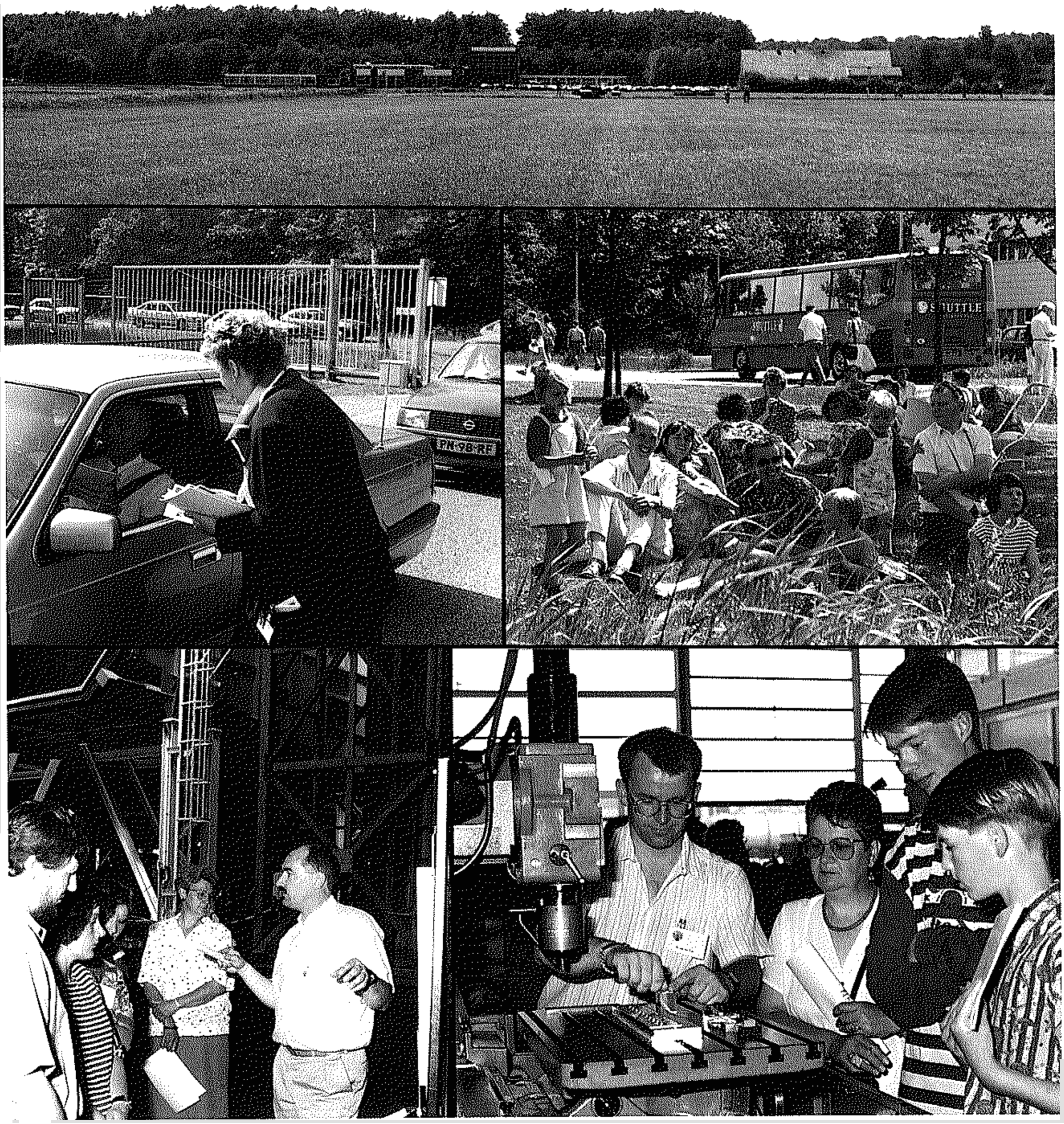
The 25th Anniversary of an employee is usually still celebrated in a grand manner unless he or she desires otherwise. The family is invited, speeches are given by one of the Directors, the Division Head, the Department Chief and Colleagues. The person celebrating his jubilee usually receives presents from his colleagues, a half month salary and a silver NLR pin. Often people from outside the laboratory are invited. These events are great social occasions with people from various Departments attending.

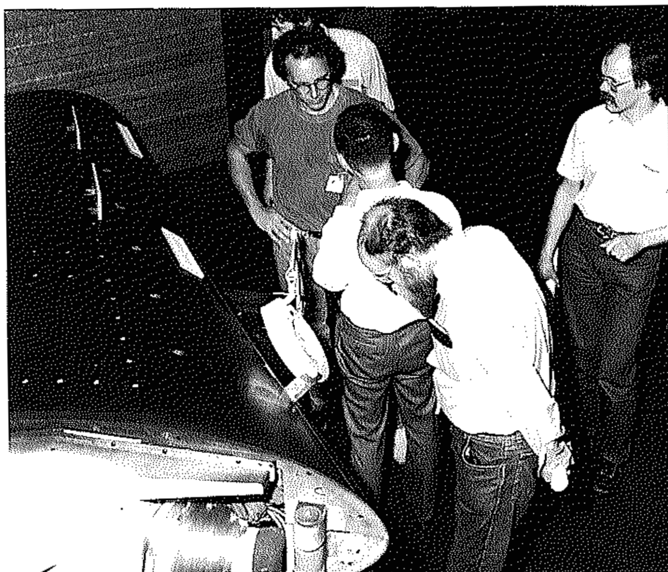
Often quite some time is devoted in the speeches to the history of the particular person at NLR. The nice part about this is that the personnel attending the festivities, learns of the ups and downs of NLR and the particular Department. Apart from the person who celebrates his jubilee, the audience learns to appreciate the past and it adds to the data base to assess NLR as an institute to which he or she devotes his or her efforts.

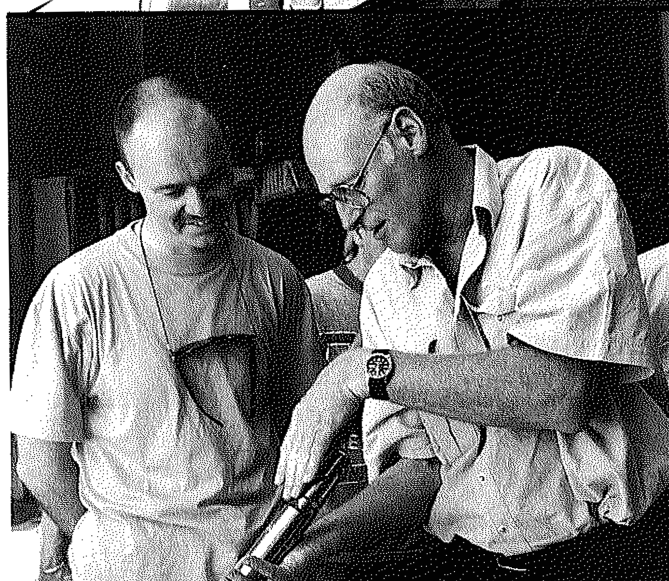
A 40th Anniversary is becoming very rare. The event is celebrated in a similar manner as the 25th Anniversary. Among the presents are one month salary and a golden NLR pin.

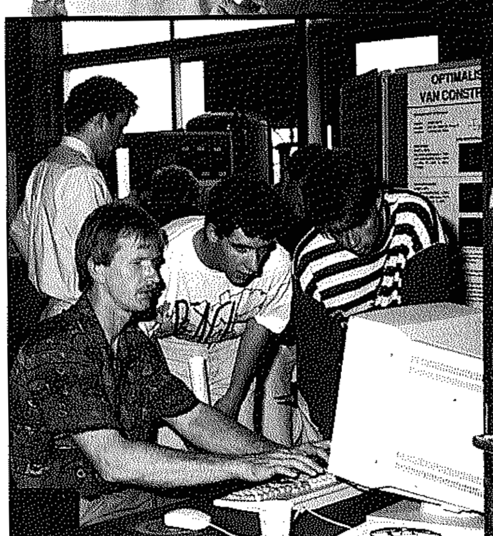
A 50th Anniversary is now impossible: the minimum age to start employment is 16 but in practice this happens very seldom. The mandatory retirement age is 65 years.

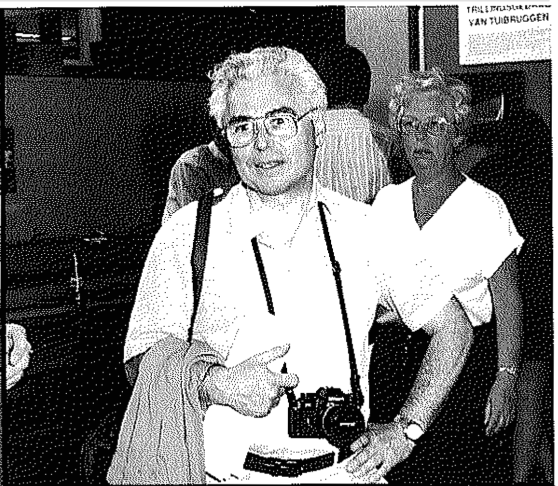
Open House Noordoostpolder 23 May 1992

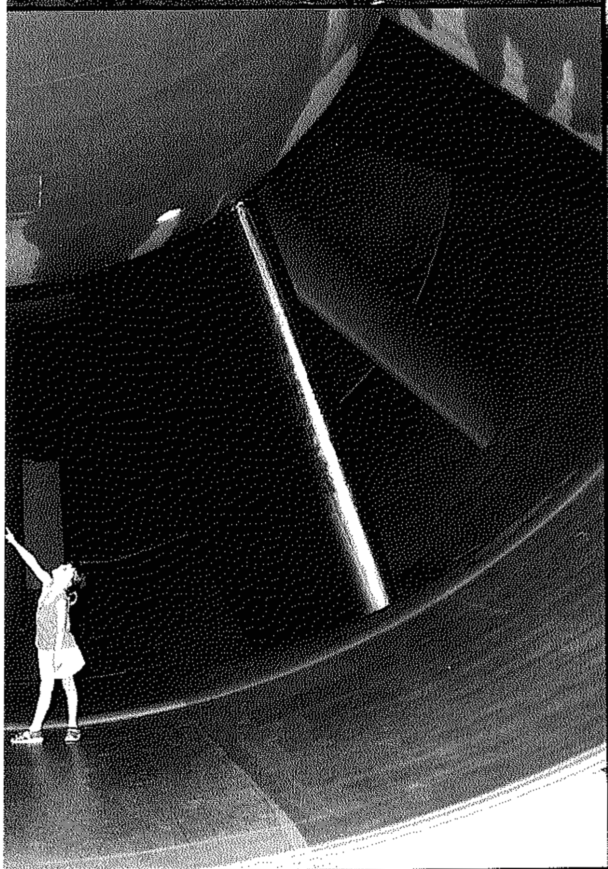


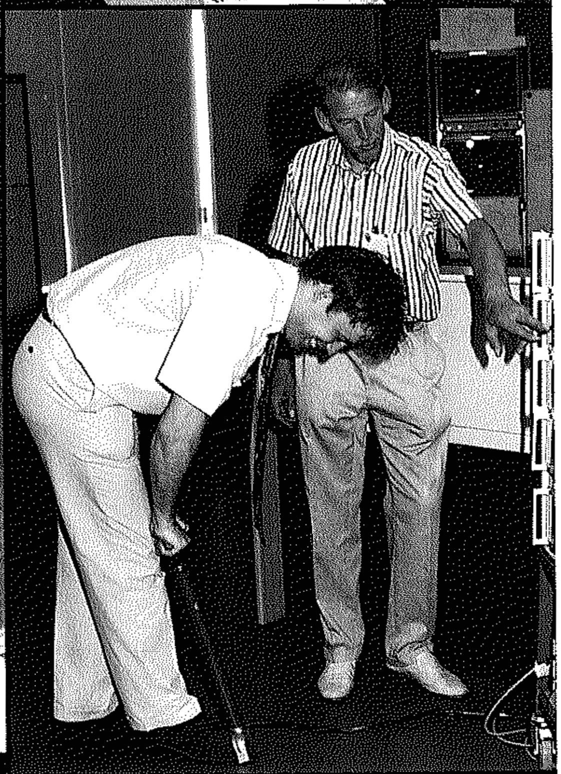


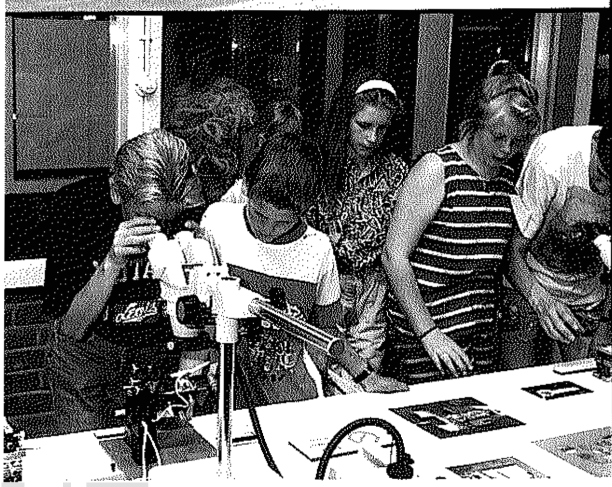










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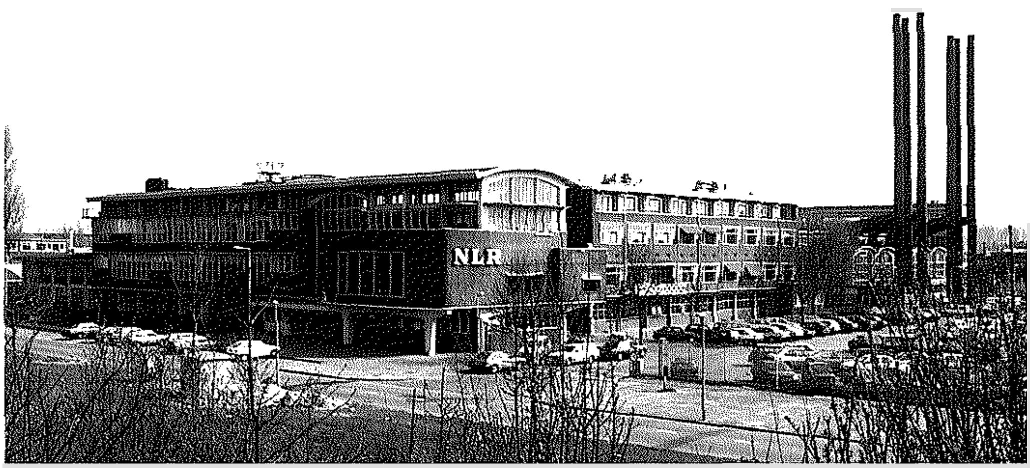
26. Buildings and Sites

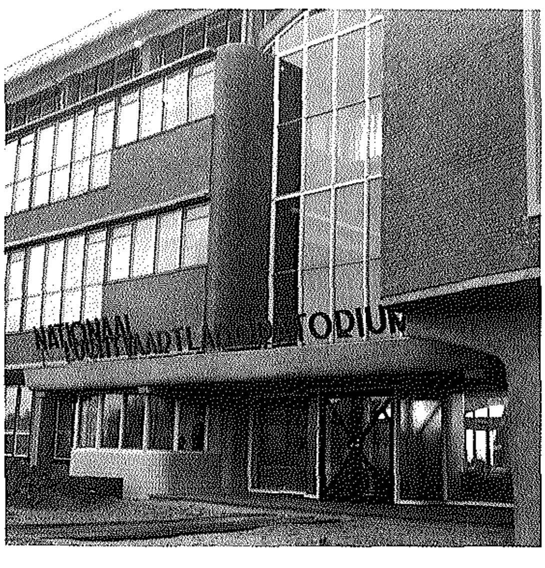
In most countries the technical laboratories, either government owned or government subsidized, cannot be considered as architectural landmarks.
Generally, the technical and operational requirements of the installations have a much higher priority in the budget than the architectural aspects of the buildings. Although this is also the case at NLR, there have been some exceptions which are interesting to mention.

The first building where the RSL in Amsterdam was housed in 1919, the 'Old Saw Mill' of the Navy, was only a temporary building and little attempt was made to improve its appearance. However when, after the Foundation NLL was created in 1937, the highly regarded architects Van Tijen and Maaskant were asked in 1938 to design a new laboratory. Their original design of the buildings, including the two low speed tunnels, vertically positioned, is now regarded as an architectural landmark. Their architectural style was called 'Het Nieuwe Bouwen', which is probably best translated as 'The New Architecture'.

The laboratory in Amsterdam



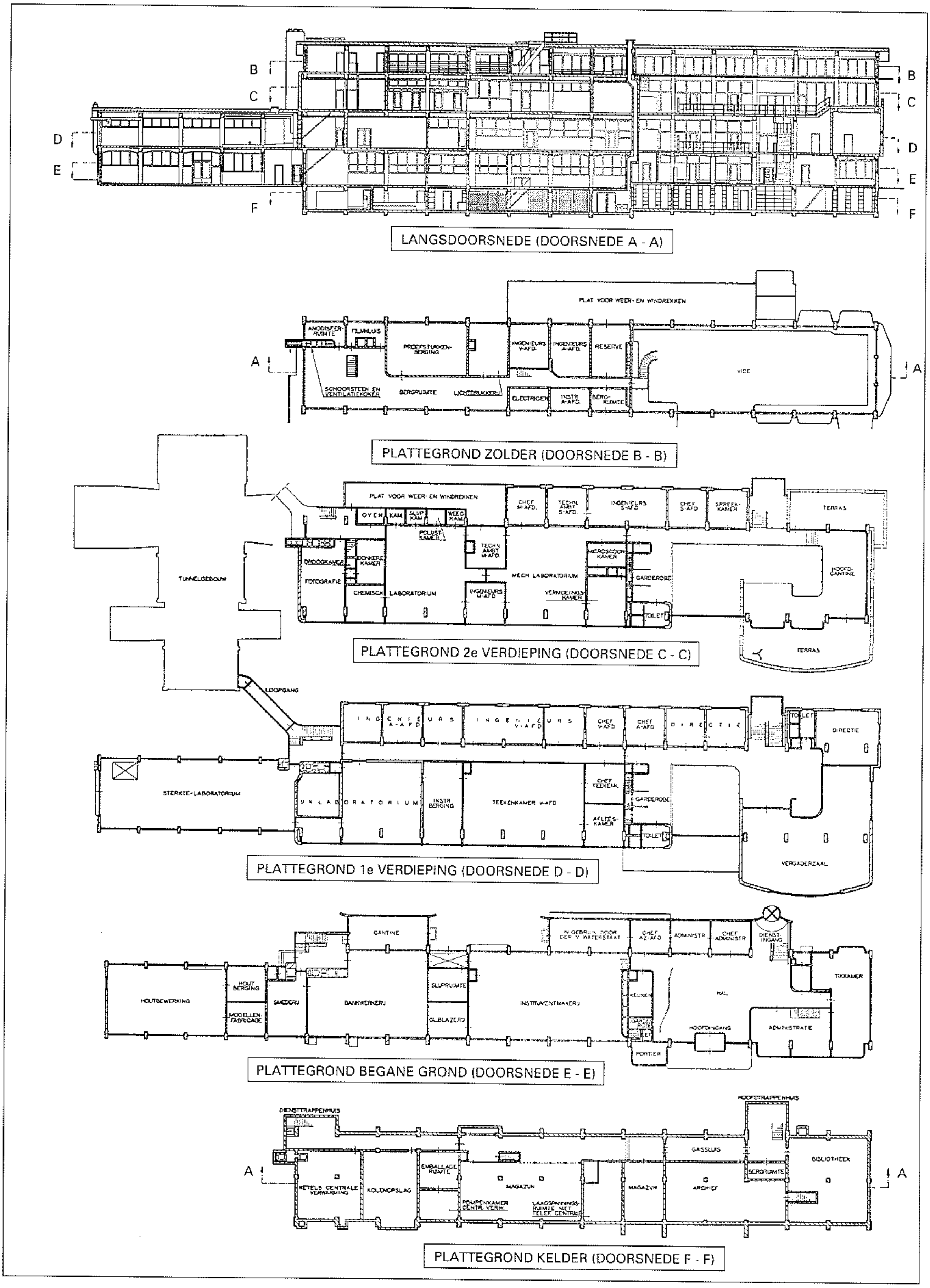
The Entrance of the laboratory in Amsterdam as designed in 1939



Particularly Maaskant has had a great influence on the architecture in The Netherlands. Among his major works are Het Groothandelsgebouw (Whole Sale Trade Building)-Rotterdam (1953), The Euromast-Rotterdam (1959), The Johnson Wax Building-Mijdrecht (1966) and Het Provinciehuis (Provincial Hall)-Den Bosch (1971), [Ref. 83].

H.A. Maaskant (1907-1977), who was associated with W. van Tijen till 1955, was involved in all the construction activities at NLR till shortly before his death. It is unfortunate that after the first NLR building in Amsterdam, completed in 1940, NLR never seemed to be in a position to give Maaskant the full freedom he needed to create another architectural landmark. Maaskant was a flexible man and he understood NLR's low budget problems and he made the best of it. He prided himself of being from Rotterdam - the city of action, the city of the 'doers'- and that must have been the reason why NLR worked with him for close to 40 years.

A Plan View of the laboratory in Amsterdam, as it was completed in 1940



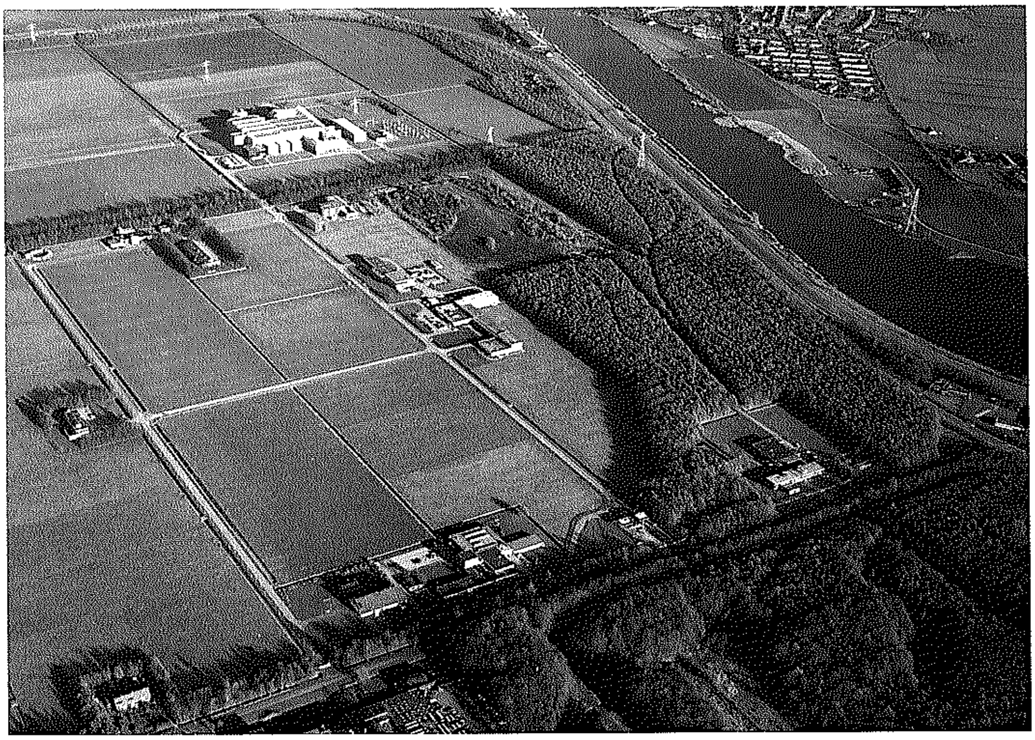
The Entrance Hall of the laboratory in Amsterdam, 1992


RECEPTIE

One of Maaskant's last designs for NLR was that of new chimneys for the Power Station in Amsterdam. Due to local environmental constraints the height of the chimneys had to be increased from 20 meter to 40 meter. This meant that a new design had to be proposed to the Building Authorities of the City of Amsterdam. Maaskant came up with some very interesting designs, including one rather massive chimney - instead of the six chimneys - which would have drawn everyone's attention, but he could not obtain approval of the City Building Authorities. Finally he divided the six rather slender chimneys in two groups of three and this did fit into the surroundings rather well.

After NLR acquired the 200 HA of land in the Noordoostpolder in 1957, Maaskant designed most of the buildings there.

An aerial view of the laboratory in the Noordoostpolder, 1993

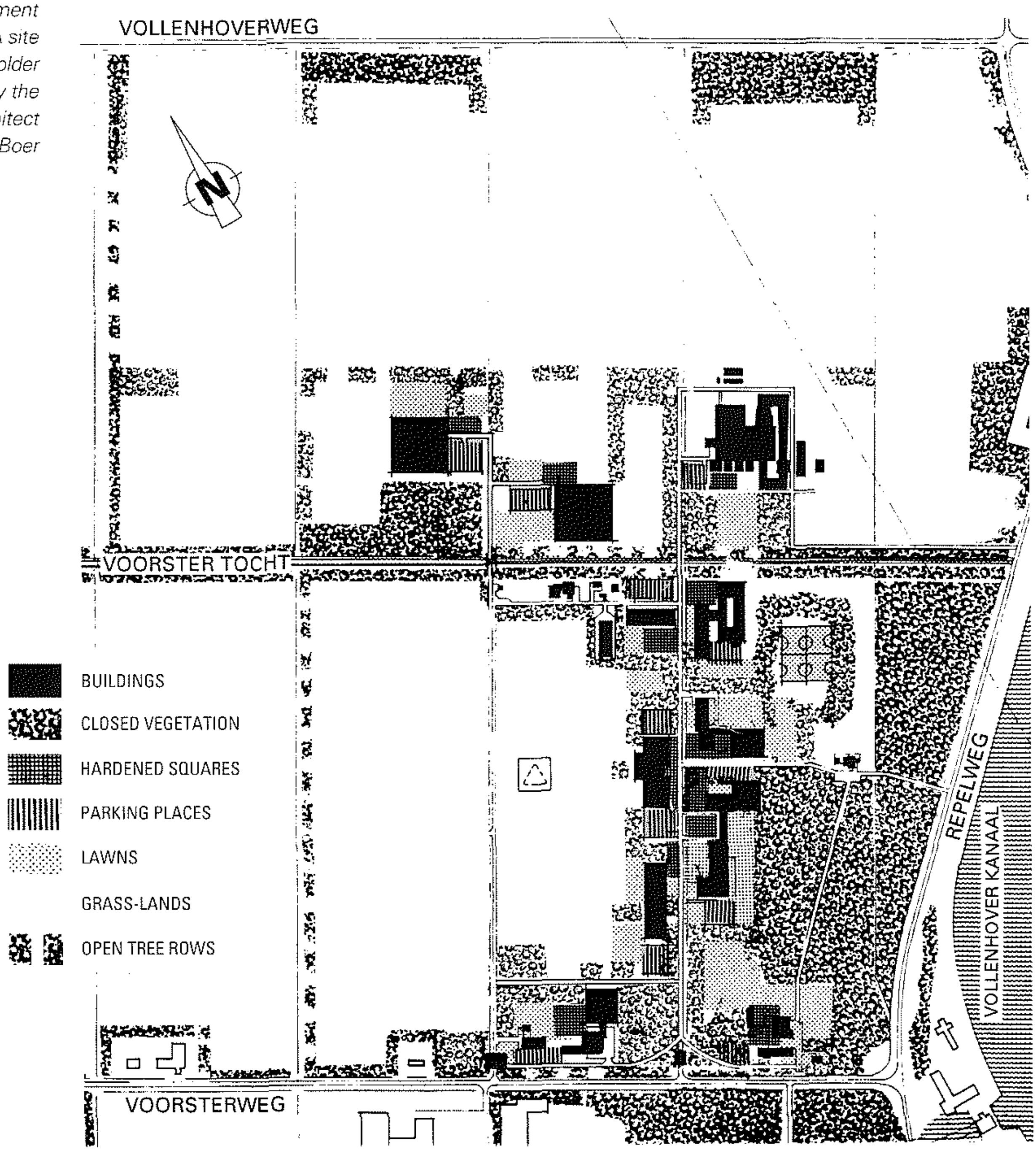


The construction of the DNW at the Noordoostpolder (1976-1980) was the largest construction job in which NLR was directly involved. This project was preceded by the design of a large low speed wind tunnel, the LST 8x6, which was later merged into the DNW design, (Chapter 18). Maaskant acted personally as project leader for the civil engineering part of the design of the LST 8x6 up till 1975. When in 1975 the initial approval for this project was obtained and when it was clear that the final design and construction would take several years, it was decided to engage another firm. Maaskant was then 68 years old. That ended a 38-year period of cooperation of NLR with the great architect Maaskant.

The architectural and civil engineering design of the DNW was carried out under the guidance of Ir. T. Tjebbes and Ir. A. Krijgsman of ABT. At an early stage Tjebbes and Krijgsman suggested that Prof. W.G. Quist (Rijksbouwmeester) be engaged to contribute to the architecture, particularly the outside and the aspects of harmonizing the design with the rural surroundings. The Management of NLR was hesitant and feared that further enhancement of the aesthetic qualities of the design would be costly and not add anything to the technical quality of the wind tunnel installation. After some discussion ABT's suggestion was accepted. The result was extremely gratifying and after the construction of the DNW was completed there was unanimous agreement on the beauty of the design and the harmonization with the landscape that was achieved.

It was perhaps particularly the DNW, by far the largest building in the area, which brought about an awareness of the fact that here NLR had in its possession an area of 200 HA on which it was constructing buildings which will be there for as much as 50 to 100 years and perhaps even more. The landscape architect Ir. H. de Boer (who had been involved in the landscaping of the 10 HA DNW site) was asked to present his views on the overall development of the laboratory site in the Noordoostpolder. Ir. De Boer pointed out that in the past land owners had the task of developing and managing their property and that now NLR was basically in a similar position with 200 HA of recently created land. He presented an overall plan in which - given the present status - future buildings, roads and vegetation (wooded areas) could be arranged in a practical and harmonious manner. It is a guide for the Management for many years to come.

A long-term Development Plan for the 200 HA site in the Noordoostpolder as proposed by the landscape architect Ir. De Boer



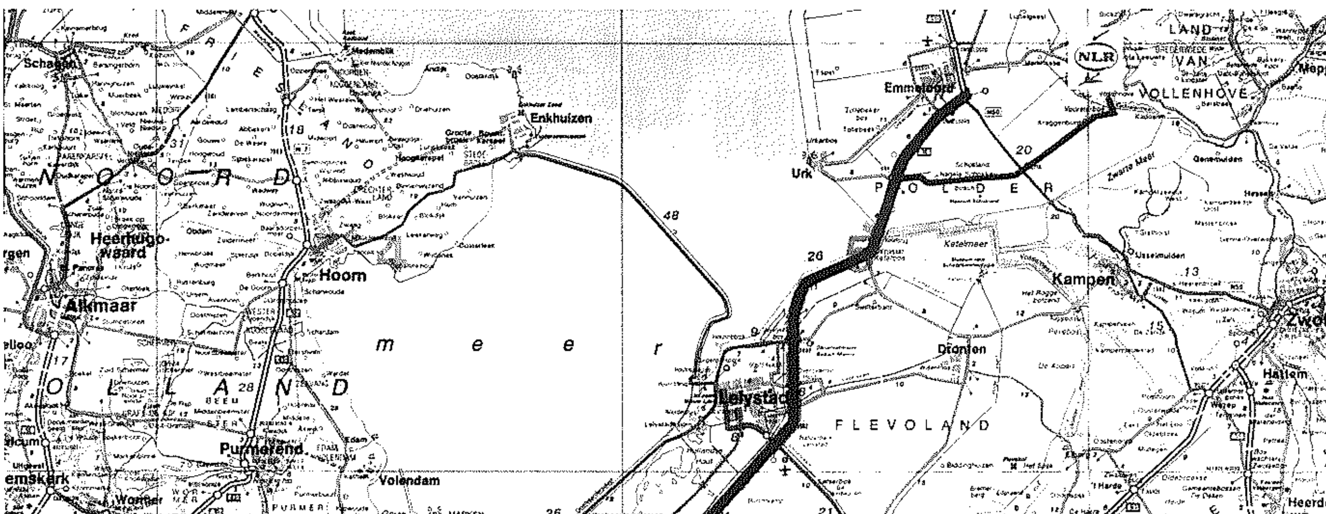
The acquisition of land

After the acquisition of the land for the new laboratory at the outskirts of Amsterdam in the late 1930's it was decided rather soon, already in 1943, to purchase another 0.264 HA on the East side of the grounds. This was fortunate since that is the place where later the HST, the SST and the Power Station were built and at the time of construction in the 1950's this might already have been impossible. Finally in 1955 another 0.5 HA was added on the South side. That was the very last piece of ground available at that location. The city of Amsterdam had expanded rapidly around the laboratory.

It was clear that for further expansions another site had to be found. An extensive search was carried out through the country. The search was accelerated by the requirement to find a site where the testing of ramjet driven rotors for helicopters could be carried out (see Chapters 7 and 12). The noise of the rotary test stand in Amsterdam became unbearable and so it was decided to look for a site near or at an airport, where there was already a high noise level or a site where there were no dwellings within a radius of 1.5 KM.

Mr. A. H. Geudeker, at that time working with Prof. Van der Maas, recalled later that he accompanied Prof. Zwikker, the Director, every Friday on visits to different potential sites. One Friday, on their way back from a visit to Groningen, in the North of The Netherlands, where they had been looking into the possibility of acquiring property near the airport Eelde, they met Prof. Ir. J.T. Thijsse in the train. He pointed out the advantages of the NOP, the Noordoostpolder, where his Hydraulics Laboratory had started new activities. There was ample space, sufficient electrical power and also good access to cooling water. Also the housing conditions for the personnel - at that time still very problematic around Amsterdam - were very favorable. After a period of deliberations and negotiations an area of 200 HA was purchased (bought in two stages) in the Noordoostpolder in 1957. In 1958 the first NLR employees started their pioneering work there. It was indeed pioneering. The Noordoostpolder had been reclaimed from the former Zuiderzee and could be considered 'dry' in 1942, but the first 105 permanent settlers did not arrive till 1947.

The two laboratories are now connected by a Four-lane Highway

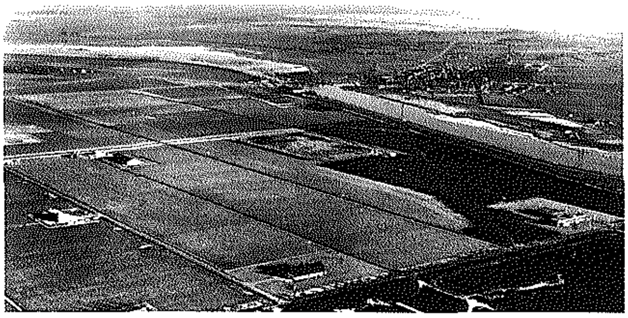


The trip from Amsterdam to the new laboratory site in the Noordoostpolder (NOP) took four hours by car and public transportation was complicated. The polders Oostelijk and Zuidelijk Flevoland did not yet exist. Now there is a four-lane highway connection between Amsterdam and the NOP and the trip between the laboratories takes about one hour by car.

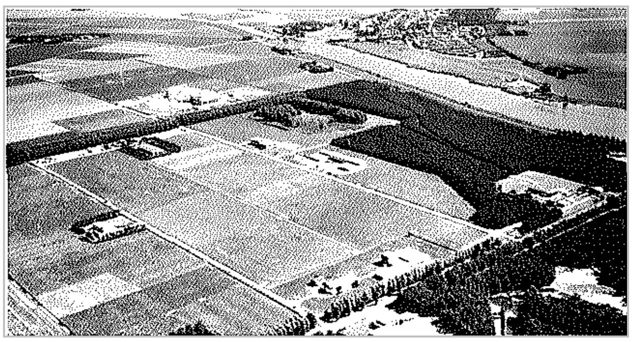
NLR was very fortunate to be able to purchase the 200 HA in the NOP. It offers enormous possibilities for a very long time to come. The cooperation with the local authorities has been excellent from the very start.
The first NLR activity was the erection of a rotory test stand for the development of the rotor blades of the Kolibrie, followed by the construction of a static motor test stand.
In 1958 the construction of a hall for structural testing was completed, followed by an office building, which is now occupied by the Space Division.
In 1966 the Structures and Materials Division moved from Amsterdam to the NOP. A new office building and laboratory had been completed.
Since then there has been a gradual shift of activities from Amsterdam to the NOP and several buildings were added.

Aerial view of the laboratory site in the Noordoostpolder, Period 1959-1986

1959



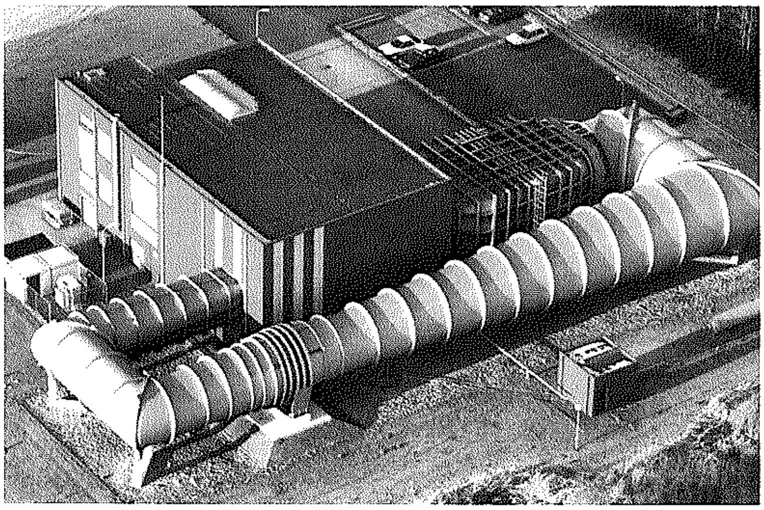
1964



1977

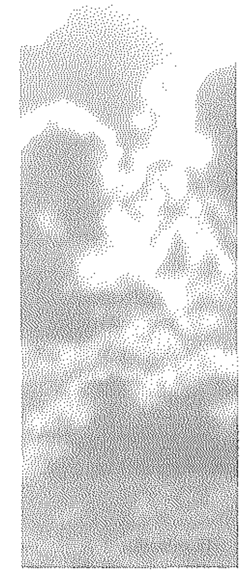
1986

The Low Speed Wind Tunnel LST 3 x 2.25 in the NOP



The Entrance of the NLR-NOP

27. Participation in International Agreements



International contacts have been of great importance to the laboratory from the very beginning of the RSL. In a number of cases these contacts went further then pure information exchange or cooperation in specific research projects. This Chapter reviews some of the international agreements in which NLR has participated - often on behalf of The Netherlands - during the last decades and which are of great importance for the development of the laboratory.

The AGARD Connection

The Advisory Group for Aerospace Research and Development (AGARD) is a NATO Agency, established under the Military Committee of NATO in 1952. The AGARD Headquarters is located at Neuilly-sur-Seine, adjacent to Paris, France.

It was formed as a result of recommendations made by a Conference of Aeronautical Research Directors from NATO countries at a meeting in Washington, D.C., USA, in February 1951. This meeting was proposed by Dr. Theodore von Kármán, who had been Director of the Guggenheim Aeronautical Laboratory, California Institute of Technology, Pasedena, California since 1930 and who had the position of Chairman of the Scientific Advisory Board of the United States Air Force (USAF). Dr. Von Kármán, who was almost 70 years old at that time, was very well acquainted with the aeronautical community in the world. He had been promoting international exchange and cooperation during most of his life and he knew all the people he had invited for this first meeting quite well. He was greatly respected by the USAF and was in a position to convince the military authorities of the benefits of international scientific cooperation.

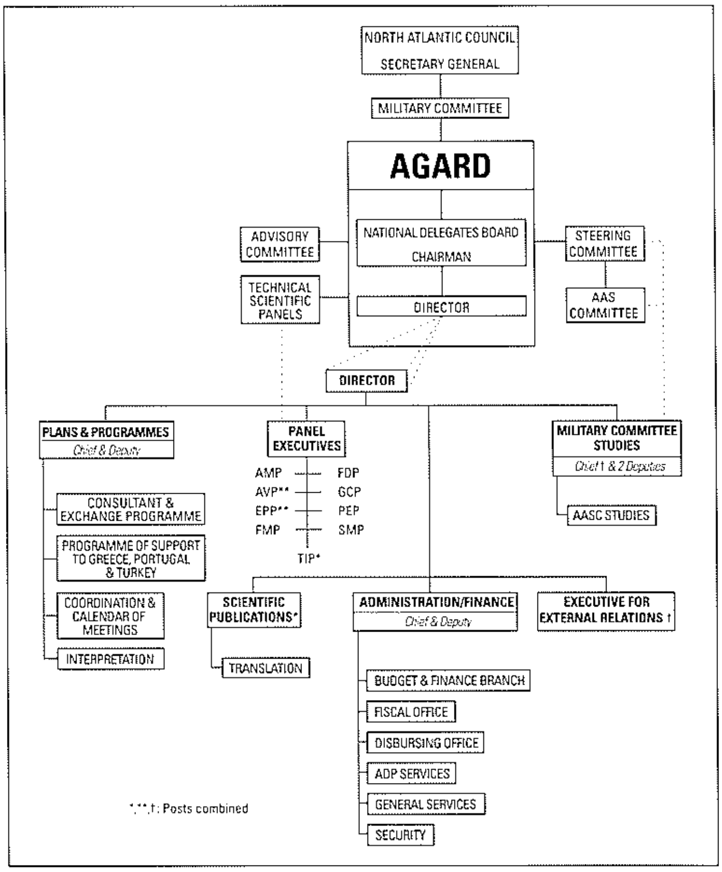
The participants from The Netherlands at that meeting in Washington were Prof. Van der Maas, Chairman, and Ir. Koning, Director of NLL. From the very beginning Prof. Van der Maas and Ir. Koning enthusiastically supported the idea of forming AGARD.

An AGARD office was established at Paris where at that time NATO also had its Headquarters. Dr. Von Kármán became the first Chairman of a Board of National Delegates of the NATO nations and he retained that position till his death in May 1963. He set up a unique organization: a Headquarters with the secretariats for Technical Panels, consisting of leading experts in the various aeronautical disciplines from the NATO countries.

The Panels, now nine[1], with a total membership of over 500, meet twice a year and organize Symposia, Specialist Meetings, Lecture Series, Working Groups and Cooperative Programs. Most of the activities result in AGARD publications - some 50-80 per year.

AGARD also has organized many Technical Consultant Missions and stimulated the assistance from one nation to another.

[1]The nine AGARD Panels are:
1. Aerospace Medical Panel (AMP)
2. Avionics Panel (AVP)
3. Electromagnetic Wave Propagation Panel (EPP)
4. Flight Mechanics Panel (FMP)
5. Fluid Dynamics Panel (FDP)
6. Guidance and Control Panel (GCP)
7. Propulsion and Energetics Panel (PEP)
8. Structures and Materials Panel (SMP)
9. Technical Information Panel (TIP)



The Organization of AGARD

A more detailed account of the history and work of AGARD - including the Advisory Task to NATO and the Nations - is given in [Ref. 32 and 84].
Since the foundation of AGARD in 1952, NLR has supported it strongly.
Currently the Netherlands members of the National Delegates Board - the body that supervises the operations and approves the program and budget - are Mr. J. van Houwelingen, Chairman of the Board of NLR, Dr. Ir. B.M. Spee, General Director of NLR and Maj.-Gen. Drs. D. Altena, Director Materiel, Royal Netherlands Air Force.
At present The Netherlands provides 24 members for the nine Panels: 11 from NLR and the other from the universities and other research organizations. Thus the total Netherlands membership amounts to only 5% but the contributions (and benefits), varying over the years, are more important than this small number would suggest.

For NLR it creates opportunities to participate in a true trans-Atlantic forum of aerospace research. Continuous participation in, and where possible contributions to the activities of the Panels enhances the research work of the laboratory. AGARD has been for NLR - and for many other research laboratories, government organizations, industries and universities - the breeding ground for international contacts and cooperation.

Out of the many examples of NLR contributions and benefits from participation in AGARD the following four serve as illustrations:

- NLR engineers participated in a series of publications on **Flight Test Instrumentation** and **Flight Test Methods** of the 'Flight Mechanics Panel'. With inputs from all the NATO nations involved in military and civil flight testing, this series serves as standard reference books and it is invaluable for all specialists involved in flight testing.

- The 'Guidance and Control Panel' recently completed an extensive monograph (called AGARDograph) compiling knowledge and technical experience related to **Air Traffic Control Systems** (ATC), which is of utmost importance to those designing and operating future ATC systems. Several engineers of NLR contributed.

- The 'Structures and Materials Panel' developed **Standard Test Methods** through a series of NATO-wide Working Groups. The subjects ranged from testing of specimen (coupons) of new materials, joints and components at various laboratories to the development of standard load spectra for fatigue testing of aircraft and helicopters. Test specifications and manuals were developed, e.g., for battle damage repair of aircraft structures including composite materials and test methods for jet engine components. NLR contributed by carrying out experiments and analyses.

- The 'Fluid Dynamics Panel' compares and validates **Computational Fluid Dynamics Computer Codes**. These important modern design tools are of interest to all nations involved in aerodynamic designs. Small errors can cause large effects in performance and economics of aerospace vehicles. Here all participants benefit from the experience of others and, under the umbrella of AGARD/NATO, laboratories and industries are frequently willing to exchange their experience. In this 'CFD Age' it is a development analogous to the testing of AGARD standard models in various wind tunnels in the 1950's and the 1960's.

After the German re-unification and the greatly improved East-West relations in 1989-1990, the defense budgets of the NATO nations were reduced considerably and it was feared that the AGARD activities would also have to be reduced considerably. So far this has not been the case since AGARD plays an important role in the 'technology readiness' for the military and also since the civil applications are of great importance. The relaxed political situation has opened up the possibility of intensifying the relations between aerospace R&D in the former 'East Block' countries and in the NATO countries and so the role of AGARD may be expanded in the coming years.

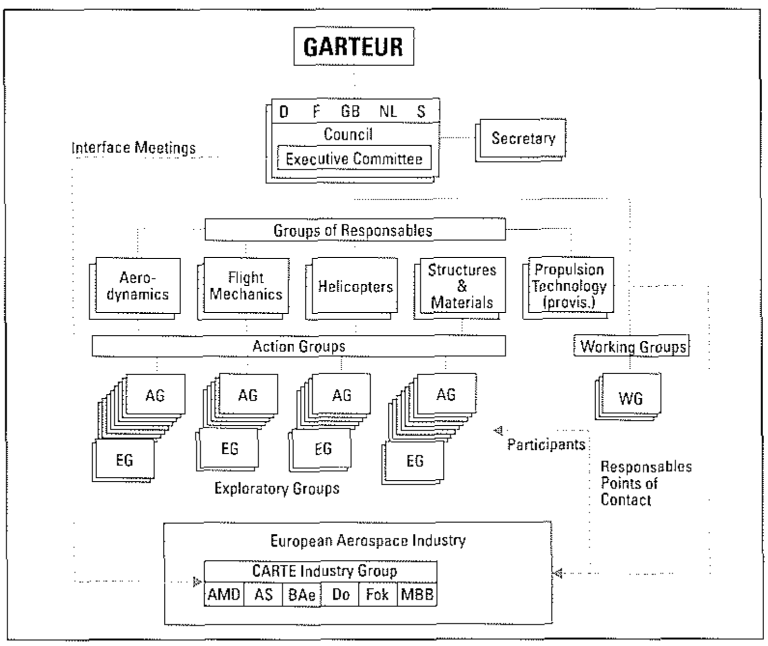
GARTEUR Activities

The 'Group for Aeronautical Research and Technology in Europe', GARTEUR, was formed in 1973 by Government representatives responsible for aeronautical research in France, Germany and the United Kingdom. In April 1977 The Netherlands joined this Group. At the end of 1991 Sweden, with its aeronautical research laboratory FFA, joined GARTEUR. Membership of Spain (INTA) and Italy (CIRA) is under consideration.
The aim of GARTEUR is to strengthen the collaboration in aeronautical research and technology between European countries with major research and test capabilities, and with government funded programs in this field. Starting with exchange of information on their respective national programs, several cooperative research programs were set up.

At the end of the 1970's it was decided to give GARTEUR a more formal status in the form of a Memorandum of Understanding (MoU) between the Governments of the four countries. This MoU, which became effective on 6 April 1981, laid down the rules for the cooperation:

- each member country would finance its own activities, no common fund was established;
- rules for handling security matters and intellectual property rights were established;
- in a Charter the organization and the mode of operation was described.

The Organization of GARTEUR



GARTEUR is governed by a **Council**. Most of the Council Members are from the research establishments DLR (Germany), DRA (UK), NLR (The Netherlands), ONERA (France) and FFA (Sweden), which are also the organizations where most of the work under the auspices of GARTEUR is carried out. Out of the Council Members an **Executive Committee**, consisting of one member per country, is formed. The Executive Committee handles the daily business of GARTEUR. The Secretariat rotates periodically between the countries.
There are now five '**Groups of Responsables**'[2] concerned with:

- Aerodynamics
- Flight Mechanics
- Helicopters
- Structures and Materials
- Propulsion Technology

Each Group of Responsables reviews its field of interest and proposes '**Action Groups**' with clearly defined tasks to be performed within specified periods. An Action Group is really an international project group whereby the participating institutes commit themselves to carry out a part of the project within a specified period of time. The Groups of Responsables, who are usually

[2] The term 'Responsable' was coined by the committee drafting the Memorandum of Understanding and the Charter of GARTEUR.

Department Chiefs or Division Heads in their laboratories, review the progress and the reports of the Action Groups. *Thus GARTEUR is a mechanism for carrying out joint research projects* internationally on a regular basis, sharing the work and the use of the facilities.

The Council and the Executive Committee meetings offer the possibility for the research establishments to become further acquainted with each others interests, problem areas and future plans. Although the funding of the laboratories is still on a national basis and although there are also competitive aspects involved as the research approaches practical applications, there are many areas of common interest and many possibilities for fruitful joint actions.

Specialists of industry and university participate in some Action Groups. Since the main purpose of GARTEUR is to carry out joint research projects with the aim of improving the European technology base, a group of representatives of the European aircraft industry (called CARTE) reviews the GARTEUR program and advises the Council.

During the past few years, at any one time, NLR participated in 15 to 20 Action Groups. This, combined with the participation in several other international projects means that now most of the NLR in-house research is carried out within an international context.

> It has been argued that the 'visibility' of GARTEUR is not great in spite of the fact that it is based on a Memorandum of Understanding between Governments. This is undoubtedly so when compared to, for instance, the programs of the European Community, the EC, which are frequently at the center of attention in the political arena. But it must be remembered that in GARTEUR no funds cross the borders and the institutes involved do not receive additional Government funding just because projects are carried out on an international basis. The stimulus for participation is mainly based on technical-scientific considerations. Although cooperation with foreign institutes introduces additional complications, the final result is worth the extra effort: the total result is more than the sum of the parts.

The Aerotest Group and the LaWs Group

Several wind tunnel facilities had been built on the European continent shortly after the Second World War and during that War in the UK, but around 1970 there was a need for improvements, upgrading and replacing in view of the expected requirements in the coming decades.
At the suggestion of its French Delegation the NATO Defence Research Group (DRG) organized a Seminar - in May 1971 at the Institut Franco-Allemand de Saint Louis, France near Basel - on 'General Problems relating to Aerodynamic Testing Facilities'. At this meeting it was proposed to set up two Ad-Hoc Groups, by DRG and AGARD respectively, to deal with these problems.

Subsequently the DRG established an

> Ad-Hoc Group on the Collaborative Possibilities for the Provision of Major Aerodynamic Testing Facilities in Europe.

This Group, called '**Aerotest**', under the Chairmanship of Prof. J.J. Smolderen of the Von Karman Institute, consisted of representatives from Belgium, Canada, France, Germany, Italy, The Netherlands (Ir. Marx was the Dutch member), the United Kingdom, the USA and staff members of DRG.

The AGARD National Delegates Board agreed to the formation, from within the Fluid Dynamics Panel (FDP), of a **Working Group Large Wind Tunnels**.
This Group was called the **LaWs Group**. It was chaired by Dr. Küchemann of the RAE, (UK), and consisted of FDP members (among whom were Dr. Spee and Ir. Hartzuiker of NLR) and with contributions from more than 70 experts.

The Aerotest Group treated mainly matters concerned with general policy regarding cooperative design, construction and operation of aerodynamic testing facilities, including forecasting the need

for the various facilities. The results of the studies of this Group were laid down in what became known as the 'Aerotest Report'.
The LaWs Group treated the technical aspects of the requirements and the technical possibilities. These activities resulted in - besides specific technical recommendations - an extensive series of joint AGARD-LaWs reports treating many aspects of wind tunnel design and operation.

By early 1973 both Groups had completed their work. The result of this major exercise on a large international scale was:

- Four of the countries (France, Germany, The Netherlands and the UK) participating in the studies concluded a General Memorandum of Understanding for long-term cooperation concerning the provision and utilization of aerodynamic testing facilities. A **permanent Coordinating Committee** was established with the task of promoting effective cooperation among the participants.[3]
  This was certainly a step forward in a Europe where in most cases the planning of aerodynamic test facilities had been carried out in isolation on a national basis. Now at least the authorities in the partner countries informed each other of their plans at an early stage and there was the opportunity to explore forms of cooperation when planning major facilities.

- As a result of the recommendations of the Aerotest Group a Project Group was established to provide plans for a **High Reynolds Number Transonic Wind Tunnel**. A draft plan was developed for an international facility. Under a Steering Group, chaired by Ir. J.P. Hartzuiker of NLR, the Canadian Consulting Engineering Firm DSMA carried out a comparative study of four possible drive systems for this tunnel and also an engineering study of a cryogenic transonic wind tunnel. This study was contracted by AGARD on behalf of the above mentioned four nations. During the period 1973-1977 several experiments were carried out in the laboratories of the participating countries. This became Phase 1 (selection of drive system) of the European Transonic Wind Tunnel, the ETW, (see Chapter 19).

- The **Aerotest Report** and the various **LaWs reports** had brought to focus the need for **large low speed wind tunnels**. In two of the four countries, France and the UK, pressurized[4] (3-4 Bars) large low speed wind tunnels were either at an advanced planning stage or under construction at the time the Aerotest study was carried out. In Germany and The Netherlands there were plans for large atmospheric low speed wind tunnels.
  On **30 September 1974** after attending the opening session of the Annual Meeting of the International Astronautical Federation, the IAF, which was held in Amsterdam, Prof. Dr. H.L. Jordan and Prof. Dr.-Ing. F. Thomas, members of the Managing Board of DFVLR proposed to the Chairman of the Board, Prof. Gerlach, and the Directors of NLR, to consider the merger of the German and Dutch wind tunnel plans into a joint facility. During the following months technical and organizational studies were carried out and by the end of 1975 agreement was reached about the construction and operation of the German-Dutch Wind Tunnel, the **DNW**, (see Chapter 18).
  This move was certainly stimulated by the Aerotest exercise which had assisted the laboratories to understand and appreciate each other's plans, but it was also stimulated by the mutual appreciation and trust that had developed between NLR and DFVLR since 1971 when joint research projects had started.

[3]After the GARTEUR organization had been effective for some years this Coordinating Committee was absorbed in GARTEUR in which the same representatives of the same organizations were represented.

[4]By operating a closed circuit wind tunnel under pressure, a higher Reynolds Number can be obtained at the test section than by operating the tunnel at atmospheric pressure in the test section of the same size. There are however many complicated tests, which are difficult, if not impossible, to perform in pressurized wind tunnels such as aero-acoustic tests where a large open space around the test section is required to carry out meaningful acoustic measurements. As it turned out, the German GUK and the Dutch LST 8x6 proposals, which later merged into the DNW, an atmospheric type wind tunnel was an excellent choice in this European context.

The Effects on the Operation of NLR

The above illustrates that the character of international cooperation changed from information exchange during the 1950's and 1960's to joint research and joint ownership and operation of facilities in the 1970's and 1980's in selected areas. This development was and will be determined largely by the political and industrial development in Europe.

In spite of the emphasis on the European aspects of this cooperation, the link with North America, so much stimulated by AGARD, has been maintained. The partners on both sides of the Atlantic Ocean have become more equal in many technical areas. There is often fierce competition between the USA and Europe, but there is also competition inside the USA and inside Europe and, fortunately, there has been and there will be enough room for technical-scientific exchange of information and cooperation across the Atlantic whenever that promises to be advantageous to the parties involved and when common security is at stake.

For NLR these developments have been very useful and the Board and the Directors of NLR have always been very supportive of any useful international cooperation. The Netherlands Government, the Ministers involved and particularly the Minister of Transport and Public Works and the Minister of Defense, have left NLR sufficient freedom to work on these relations. This meant that a consistent policy could be pursued.

Compared to the larger sister organizations it was often felt that at NLR international affairs required relatively more effort on the part of the fewer leading engineers. Fortunately NLR managed to stay at par with the international developments, at least in the selected areas which were considered important for the future. The trust and confidence NLR enjoyed from the Government and the organizations represented on the Board certainly contributed to this effective participation in the international network of aerospace research.

There were many more international encounters during the last decades. Apart from pure contract research for the industry, these include:

- agreements with NASA, the USAF, the FAA;
- participation in ICAO Working Groups and Studies, including such subjects as obstacle clearance, separation distances above the Atlantic Ocean and the Committee on Future Air Navigation Systems (FANS) - as part of the support to the Civil Aviation Department RLD;
- contract research under the auspices of EUROCONTROL, related to Air Traffic Control, such as flight simulation of MLS systems - also often as part of programs in which the RLD participates;
- research carried out under the aegis of the Independent European Programme Group, the IEPG, where research is carried out in an international context to strengthen the technology base of the European defense industry;
- participation in the Aeronautical Research Program of the European Community, the EC.

None of these have the relatively simple form of contracts and particularly the IEPG and the EC research projects which involve many industries, research institutes and universities, demand more time and effort to formulate and execute the programs than 'normal' research projects.

Related developments in Europe

The first international laboratory related to aerospace research is the 'Institut Franco-Allemand de Saint Louis', founded in 1959 by the French and German Governments and located at Saint Louis, near Basel. It is a specific bi-national institute and its mission is research in the field of weapons, funded by the two Governments. Although it is not a specific aerospace research laboratory it has contributed to the development of aerospace research measurement techniques and instrumentation.

Under the auspices of NATO there are several international research and development organizations in Europe:

- SACLANT Center at La Spezia in Italy for underwater research;
- SHAPE Technical Center, at The Hague, giving technical support to SHAPE, the Supreme Headquarters of the Allied Powers;
- NACISA, at Brussels, concerned with communications systems;
- Weapon Systems Test Centers at various locations.

These are however all very much dedicated NATO Agencies and have limited direct relations with the technical-scientific community in the participating countries, except perhaps the Center at La Spezia which does carry out more basic research in underwater sound propagation.
There is also AGARD, a NATO Agency, which operates quite differently as was explained above.
In The Netherlands the Defense Division of TNO coordinates the various contacts and agreements between the institutes in The Netherlands and organizations in other countries. A special committee, in which NLR participates, reviews annually the status of the cooperative agreements.
It is important to maintain these contacts, be it for defense or civil purposes. In fact, the relations often built up for common defense purposes will be very useful in the future, either for defense, the environment, the integration of the former 'East Block' countries or assistance to the world to come.

The Future

International exchange of information and cooperation is likely to grow further in the future. The idea of a European NASA, or rather a European NACA, has been advanced several times. There are now regular contacts between the managers of the aerospace laboratories in Europe and cooperation is sought whenever this seems beneficial and practical. However the formation of a central institution for aeronautical research in Europe does not now appear on the horizon. There are many historical reasons for this, many of which still stand, mostly related to the national defense and the national industrial interests.
The aeronautical technology research programs carried out by the European Commission, the EC, are a step in that same direction but the organization is quite different and it is somewhat doubtful that a European NACA will ever develop from these programs.

The investments in international aeronautical research facilities have, up till now, been limited to wind tunnels (DNW and ETW). Over the years proposals have been advanced for other international investments such as flight test centers, flight simulation centers and large central computers. Although cross use of this type of facilities has taken place on several occasions, there never was a sufficiently broad base to support such international investments.

Space technology laboratories in Europe started much later than the aeronautical laboratories and in a different political setting. It is not surprising then that the space sector developed somewhat differently. After the period of 1962-1972, during which the European Space Research Organization (ESRO) and the European Launcher Development Organization (ELDO) were active, the European Space Agency (ESA) was founded. The ESA organization, funded by the Governments of most European countries does supervise a space technology program, carried out by European organizations. That program is partially supplemented and supported by in-house ESA research.

Finally an important factor for NLR is that in 1993 the German Aerospace Industry DASA acquired a majority share in the Fokker Aircraft Company. This will undoubtedly lead towards a further intensification of the cooperation of DLR and NLR - started more than 20 years ago - and also with other European aerospace research institutes.

28. Contributions to International Development Cooperation

During the period immediately following the Second World War NLR received assistance from North American and British scientists and engineers, indirectly through publications and directly through consultants. Although the aeronautical research infrastructure in The Netherlands was basically still there in 1945, it had not been updated and the knowledge and experience was, with some exceptions, at a lower level than in the Anglo-Saxon countries. Thus assistance from North America and the UK was highly appreciated.

In later years NLR was in a position to assist organizations in other countries in developing their capabilities. A few examples are discussed in this Chapter.

Cooperation in the Framework of AGARD

The Advisory Group for Aerospace Research and Development, AGARD, founded in 1952, (see also Chapter 27), has in its mission statement i.a. *"Providing assistance to member nations for the purpose of increasing their scientific potential"*[1]. The main mechanism for this is the Consultant and Exchange Program of AGARD, by which Consultant Missions from one country to another, Lecture Series and Special Courses are organized.

A special Program of Support to Greece, Portugal and Turkey was developed at the request of the Military Committee of NATO during the 1980's. Special funds were made available to cover the marginal costs. NLR participated in a number of the projects started under this program. Some examples are listed below.

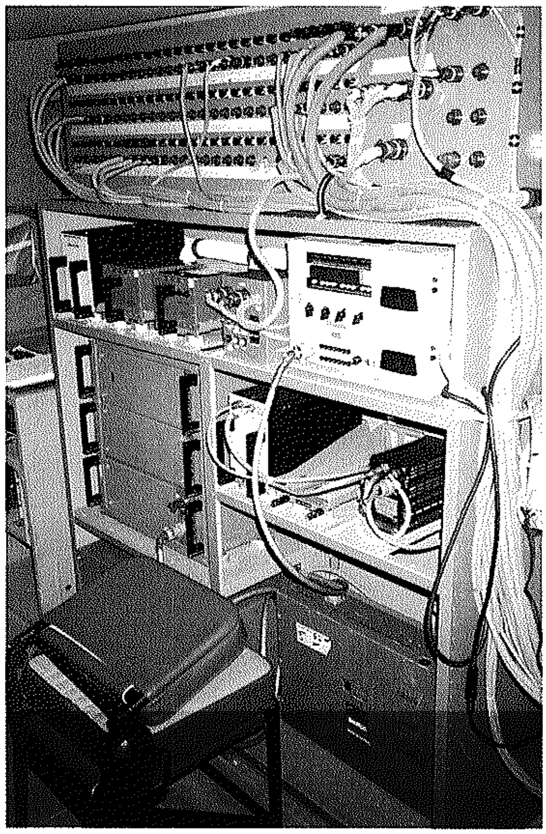
Cooperation with **Portugal**

Development of a Flight Test Capability.

During the period 1984-1991 NLR and DLR cooperated with the Instituto Superior Tecnico (IST) at Lisbon, Portugal in the establishment of a flight test capability. The Portuguese Air Force made available a CASA 212 Aviocar aircraft to the IST of Lisbon for flight testing. Under the auspices of the AGARD Support to Nations Program, some funds were made available for travel support of the personnel involved but the available funding was not sufficient to instrument the aircraft adequately. It so happened that NLR was involved in developing a new flight test system for the Fokker 50 and the Fokker 100 and that the older, but still very valuable, system became surplus.

[1]That mission statement is in line with the goals of NATO. It was important to build a security system in which all member nations could rely on each other. Dr. Von Kármán's philosophy was that aerospace engineering knowledge and experience should be exchanged internationally whenever possible and that did fit into the NATO philosophy of building a strong Alliance. It was somewhat idealistic but the idea of NATO itself was far more idealistic than many of its adversaries, both inside and outside of NATO, recognized.

After transfer to Portugal, NLR Flight Test Equipment was installed in the Portuguese CASA 212 Aviocar aircraft



The equipment was transferred to Portugal and arrangements were made whereby Portuguese personnel was trained in flight testing and instrumentation by DLR in Braunschweig and some technicians received instruction at NLR in the use and maintenance of the equipment. NLR personnel assisted in installing the instrumentation in Portugal and finally in the testing and execution of the first flight.

In a presentation of a research project carried out with this aircraft, Prof. L.M.B.C. da Costa Campos of IST Lisbon recalled the history of this support project, [Ref. 85].

Cooperation with **Turkey**

Development of a Materials Laboratory at the Sea of Marmara, Turkey.

In the late 1960's Dr. Ir. H.P. van Leeuwen, Head of the Structures and Materials Division of NLR, advised the Turkish authorities on the development of a materials laboratory in Turkey. There were others involved in the planning and realization of this laboratory but the sharing of the NLR experience was a useful contribution. There is now a full-fledged laboratory supporting industry and government.

Cooperation with **Greece**

Flutter clearance and counter measures.

During the 1980's NLR assisted Greece in developing a capability to determine the operating limits for safe clearance of stores jettisoned from aircraft during flight and also provided assistance in the applications of counter measures of aircraft.

Library and Documentation Services (Greece, Portugal and Turkey)

NLR and TDCK (the Technical Documentation Center of the Netherlands Ministry of Defense) provided over a period of several years assistance in organizing library and documentation services to Greece, Portugal and Turkey. This was often done in cooperation with other documentation centers of the NATO countries.

These are a few examples of the assistance program under the auspices of AGARD in which NLR contributed. Of course over the years NLR itself benefited from consultants of other countries who spent from a few days up to several weeks at NLR discussing current research problems. In the 1950's and 1960's American consultants contributed significantly. Later NLR was in a position to assist others in obtaining solutions to their research problems.

Cooperation with Indonesia

The NLR involvement in the cooperation with Indonesia was part of the Development Cooperation Program of the Netherlands Government. It was of a different nature and of a different magnitude. It started in November 1979 when Prof. Ir. O. Diran, Professor of Aeronautics at the Institute of Technology Bandung (ITB), paid a visit to NLR accompanied by two young engineers. He had been asked by Prof. Dr.-Ing. B.J. Habibie[2], Minister of State for Research and Technology of Indonesia and Head of the Agency for Development and Application of Technology (abbreviated as BPPT in Indonesia), to explore the possibility of a cooperation with NLR in developing a low speed aerodynamics laboratory in Indonesia as part of the Science and Technology Center (PUSPIPTEK) located near Serpong, some 30 km South-West of Jakarta[3].

At that Center a Structures and Materials Laboratory (called LUK in Indonesia) was already under construction with the cooperation of Germany. It included a large hall for static and fatigue testing of complete aircraft. At the Center several other science and engineering laboratories were either under construction or in the planning stage.

The plans for the aerodynamics laboratory included a low speed wind tunnel of sufficient size to be used for the development of aircraft. Prof. Diran, a graduate of the Technical University Delft, had visited NLR and other European aeronautical laboratories during the years before and he was well acquainted with the status of the European laboratories. The request was to apply the experience gained with the design of the LST 8x6 and the experience gained with the Pilot Tunnel to the design of an Indonesian wind tunnel. The components of the facility should be manufactured in Indonesia as much as was practical and economically feasible.

With the approval of the Board of NLR a mission of three (Ir. Van der Bliek, General Director - Dr. Van Leeuwen, Head of the Structures and Materials Division and well acquainted with Indonesia - Capt. Jager of the NLR Board Office) went to Indonesia to:

- present and discuss a preliminary plan based on the discussion with Prof. Diran;
- become familiar with the state of technology in Indonesia;
- make an inventory of the tasks which would have to be carried out to design, construct and operate the facility.

The report of the mission was very positive about the feasibility of the project and it indicated additional areas where The Netherlands could contribute. The Board of NLR fully approved the recommendations and by the end of 1980 a plan was presented to the Netherlands' Government for incorporation into the Development Cooperation Program of the Government. This plan included:

- Assistance in producing a 'Masterplan' for the 'Laboratory for Aero-Gas Dynamics and Vibrations' - the LAGG as it was called in Indonesia. This was really the overall plan of an aeronautical research laboratory, including low speed aerodynamics, high speed aerodynamics, flight mechanics (a detailed plan for a flight mechanics laboratory was made by DLR), aero-acoustics and vibrations, and computational methods.

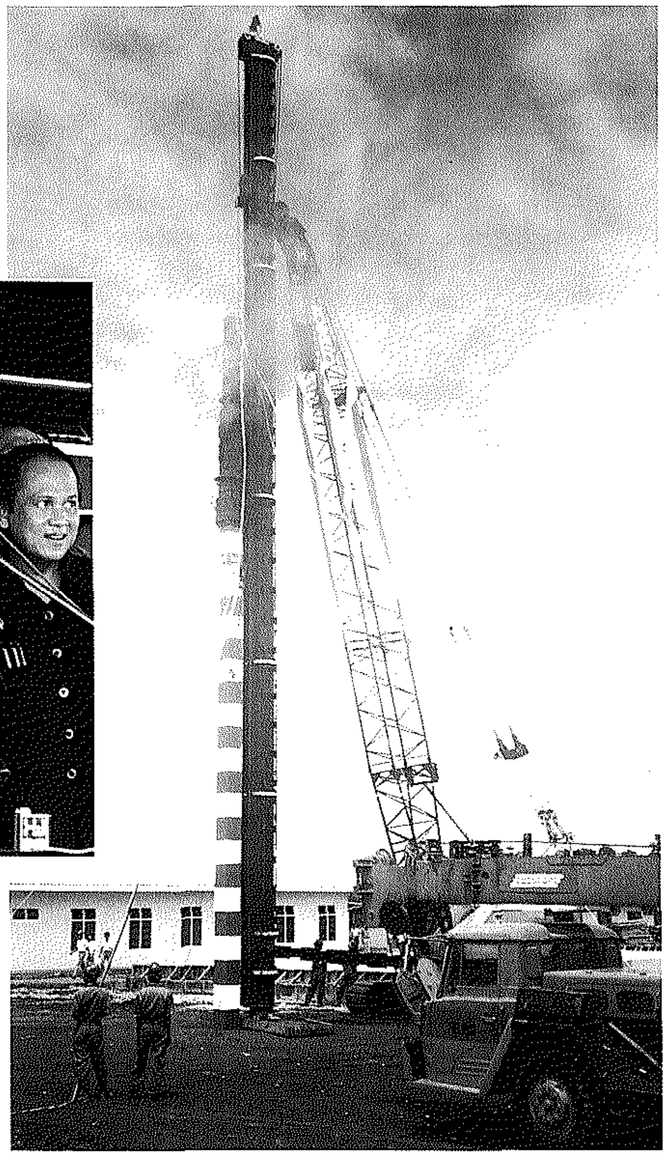
- Assistance with the design and construction of the Indonesian Low Speed Wind Tunnel, the ILST. This was really the **main part of the program**. It consisted of transferring the design of the LST 8x6 to Indonesia, transforming it into a 4x3 M^2 tunnel, and the assistance with the design and construction.

[2] Dr. Habibie studied aeronautical engineering at Aachen, Germany and worked for several years at the German aircraft manufacturer MBB at Hamburg (now part of DASA) before he was asked by the President of Indonesia to take up the position of Head of BPPT. Later he became Minister of State for Research and Technology.

[3] This activity is part of Indonesia's long-term plan to develop its aeronautical industrial capabilities. Prof. Habibie outlined these plans and policies, [Ref. 86] on the occasion of the 10th Anniversary of the aircraft industry IPTN when an international aeronautical exhibition and a symposium were organized at Jakarta.

An Indonesian Project Group was set up with Ir. F. Jaarsma, who had been the Project Director of DNW during its Construction Phase, as the chief advisor to the Group. This meant that the most recent experience in designing and constructing such a facility was incorporated. An Engineering Consortium was formed consisting of Dutch and Indonesian Consulting Engineering Firms to carry out the detail design and management of the construction. Ir. Jaarsma was supported in his task by NLR personnel whenever that was necessary. This was referred to as backstopping.[4] During the design and construction phase several engineers of NLR were involved in consulting roles. In a few cases NLR had the role of a contractor for the ILST as e.g. when NLR obtained a contract from the ILST Project Group to design and manufacture (with an industrial sub-contractor) the data acquisition and reduction system. A strict division of the advisory role and the contractor role was necessary.

The first pile for the ILST was driven into the ground in the presence of President Suharto, Minister Habibie (Indonesia) and Minister Schoo (The Netherlands) on 18 December 1985



[4]The expression 'backstopping', not found in the Oxford dictionary, is in general use among people working in development cooperation in The Netherlands and the development workers use it as a Dutch word. Presumably it is derived from the American base ball game and it refers to the screen preventing the ball from going too far from the playing area. In the context of this project it clearly refers to the fact that Ir. Jaarsma could continuously rely on the support of his organization (NLR) for technical support.

Indonesian craftsmen and their instructor at NLR after having completed their first Wind Tunnel Model for the ILST

- The training of the personnel who were to operate the facility. To this end many of the Indonesian engineers worked at NLR during this period and participated in aerodynamic testing, including participation in the calibration of the DNW which partially coincided with the training period. The training included all aspects of operating an industrially oriented wind tunnel. A team of the ILST personnel participated in the design and manufacturing of the first wind tunnel model at NLR, - a model of the CN-235 - for the ILST.

- The assistance in developing the aeronautical engineering education at ITB, the Institute of Technology (Technical University) at Bandung. Short courses were given by university professors of the Technical University Delft and by NLR experts. The Aerospace Engineering Department of Delft cooperated with Bandung, besides in developing the curriculum, also in developing the laboratory equipment and by the end of the project an Aeronautical Laboratory as part of the Department of Mechanical Engineering at ITB was well on its way.

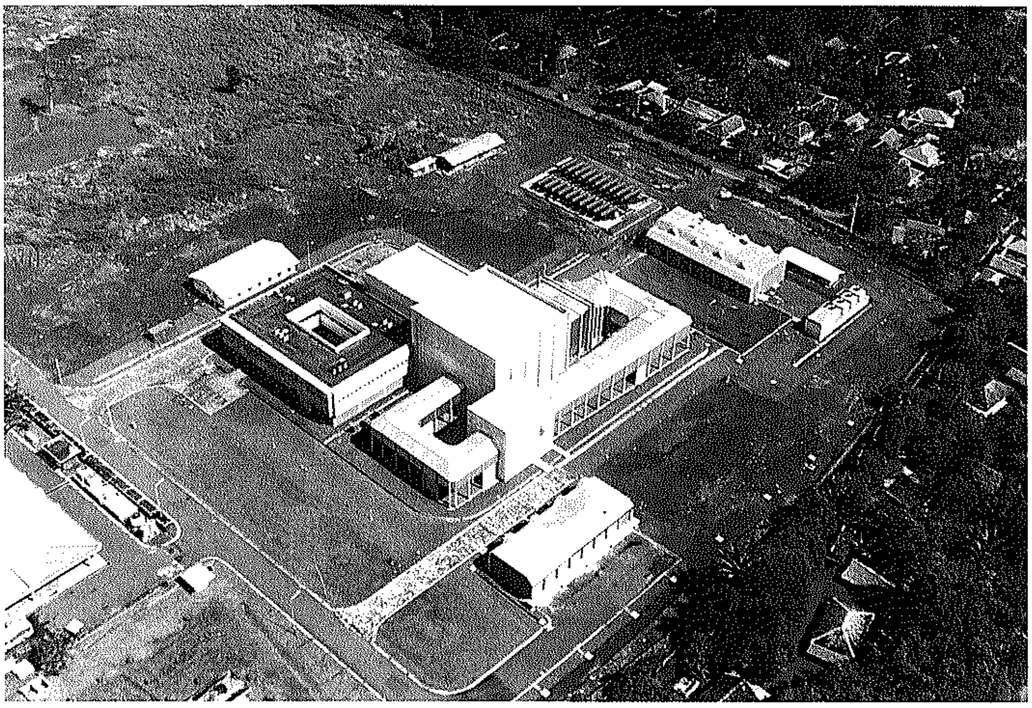
- An associated educational program, financed by Indonesia, was the enrolment of some 75 Indonesian students in the full course of Aeronautical Engineering at the Technical University Delft. Many of the graduates became leading engineers in the aeronautical industry and the laboratories in Indonesia.

- Assistance in improving the technical and scientific libraries of BPPT, IPTN (the aircraft industry at Bandung) and ITB and also to assist in improving the library, documentation and information services in these institutes. To this end two training courses were held in The Netherlands for library and documentation personnel. During this project some 10,000 documents (books, reports of aeronautical institutes, conference proceedings and journals) were transferred to Indonesia, most of these (7,500) spare-copies were not charged to the project.

The cost of this comprehensive development cooperation plan was estimated at DGL. 10 million (1981 price level) and this included the cost of NLR personnel, the travel and subsistence allowance of personnel of NLR, TUD, and most of the Indonesian personnel involved. This amount was made available by the Dutch Government for the period between May 1979 until October 1987.

The participation of many individuals in Indonesia and The Netherlands, the long distance between the two countries and the cultural differences made careful planning and project control mandatory. The overall project control was carried out by the NLR Board Office. The Chairman, Prof. Gerlach, also participated personally as Co-chairman of a Governing Group. A detailed schedule of the operations was assembled by Capt. R.A. Jager, who was in charge of project control and progress reporting. After his retirement in July 1985 Mr. J.P. Klok carried out this task.

As indicated above, the central part of the project was the assistance rendered in the realization of the wind tunnel laboratory. The design and construction was completely funded by the Indonesian Government at an equivalent total cost of about DGL. 120 million.
The result of this cooperation was extremely gratifying to all parties concerned. By mid-1987 Indonesia had with the ILST one of the world's best[5] low speed wind tunnels in operation. The NLR engineers who contributed to this success were justly proud of the achievement in an environment which was completely new to them. The support was extended during the operational phase of the ILST. After Ir. F. Jaarsma, Ir. C.C. Groothoff took up residence in Indonesia and later when the character of the operation phased into industrial testing he was succeeded by Ir. R. Ross till 1992 when Ir. S.J. Boersen took his place. The present cooperation - financially supported by Fokker and NLR - involves on the Netherlands part the Aerospace Engineering Department of the Technical University Delft, Fokker and NLR. The goal is to strengthen the ties between the Indonesian and Dutch aerospace communities and to assist further in developing the aeronautical engineering education at ITB, to cooperate in the operation and further development of the capabilities of the ILST, to cooperate with IPTN where this is practical and to explore the possibilities of long-term industrial and research cooperation.



The completed Indonesian Low Speed Wind Tunnel, ILST, near Serpong, West Java, 1988

[5]If not the best low speed wind tunnel in terms of flow quality and auxiliary equipment. Full advantage was taken of the design experience of the LST 8x6 and the DNW. The Pilot Tunnel (1/10 scale of the LST 8x6) at NLR was used to verify some of the changes in the airline for the ILST.

29. Biographies

Obviously many people, at all levels, contributed to the development of the laboratory. Some names are mentioned in this book in connection with a remarkable technical-scientific achievement or because they held a particular organizational position. Many contributed through carrying out tasks which are not glamorous to outsiders but which were nevertheless of utmost importance for an effective operation.

These include in particular the 'Services' - the General Services, the Technical Services and the Administrative Services - that is the services within the laboratory: the canteen, the guards, the workshops, the design office, the secretarial services, the personnel department, the administration, the purchasing department, the library and documentation services, the reproduction and publication services, the maintenance services, the power station, etc.

Perhaps more than in similar institutes all of the personnel greatly contributed to make NLR an effective institute and, for the large majority of the personnel, an extremely pleasant place to work.

The loyalty and dedication of the personnel to the goals of the NLR is indeed remarkable and it is definitely the greatest asset of the laboratory.

Since so many people made NLR what it is to-day, few personal details are reported in this book. For two persons who shaped the laboratory and instilled the spirit of true engineering research and service to the aerospace world an exception is made. They are Dr. Wolff, the first Director (1918-1940) and Prof. Van der Maas, engineer-pilot at the RSL/NLL (1923-1940) and later Chairman of the Board (1950-1971). Both had to cope with situations which were very critical for the survival of the laboratory. Their enthusiasm and professional behavior inspired all and set the standards for the laboratory.

Dr. Ir. E.B. Wolff

(8 January 1882 - 7 February 1941)

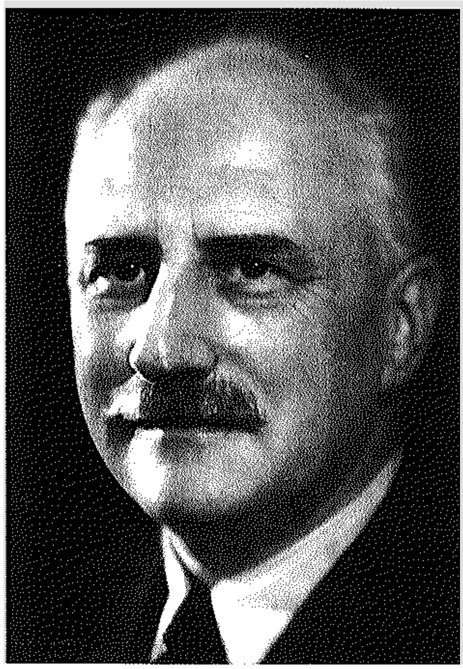
Emile Benjamin Wolff was born on 8 January 1882, The Hague. He completed his secondary education (HBS) at Amsterdam in 1899 and then went to Delft to study Mechanical Engineering at what is now the Technical University Delft, where he obtained the 'Ingenieur's Diploma' in 1904.

He was a member of the 'Delfts Studenten Corps' (DSC). He played cello and also later during his life he often played in a string quartet. He liked hiking and rowing.

During his study at Delft he worked twice during the summer period in industry as an apprentice to gain practical experience. After completion of his first year he worked at Werkspoor, Amsterdam. At Werkspoor several steam locomotives and the first electric streetcars for the city of Amsterdam were under construction. After his fourth year he worked at Sculfort Fockeday, a factory at Maubeuge, a city in Northern France, near the Belgian border. It was a factory producing machine tools. His father had a business representing Belgian and French metal industries for Spain, Italy and Austria. After graduation Wolff started to work in his father's business.

Besides Dutch, German, English and French, which he took at the HBS, he had in anticipation of this job, also taken Spanish during his HBS time and at Delft. He was well prepared for the job. In 1904 business was slow. He was interested in expanding the enterprise into trucking, but it

Dr. Ir. E.B. Wolff, 1882-1941



seemed too early to invest heavily in this sector. In fact trucks did not really become important ir The Netherlands till after 1918.

In 1905 he started to work at Werkspoor (then known as the Netherlands' Machine and Railroad Material Factory and now part of Stork). His first assignment was at the foundry where he carried out materials investigations. He started a chemical analyses laboratory at Werkspoor. Later he was given various other responsibilities and his interest broadened.
During this period he wrote a thesis entitled 'Temperature measurements in a Diesel engine' and on 5 June 1914 he was awarded the degree of Doctor in the Technical Sciences at the Technical University Delft. Prof. P.E.G.B. Meyer, who had come from Germany in 1911, was his promotor.[1] Prof. Meyer later developed lectures in transportation, including air transportation.

At the end of 1917, after $12^1/_2$ years at Werkspoor, it seemed that he was well prepared for a long career in the mechanical engineering profession. He was for instance active in the Royal Institute of Engineers (KIvI), Secretary of the Section of Mechanical Engineering and Ship Building, and a Consultant to Dikkers, a firm in Hengelo designing and manufacturing 'appendages': valves, controls, etc. Then, just before Christmas in 1917, a friend informed him that he had talked to Prof. Van Royen, Chairman of the Bureau of Ammunition, and that a plan had been developed in government circles to establish an aeronautical laboratory with a wind tunnel, materials and structures testing, and a flight testing capabilities. Dr. Wolff's name had been mentioned as a candidate to head this activity. And so, the day before Christmas, he did receive a letter from Prof. Van Royen inviting him to discuss the subject.

On 31 December 1917 Dr. Wolff had a meeting with Prof. Van Royen and he accepted the offer to organize and head the organization of an aeronautical service laboratory.

We do not know the contents of the conversation between Prof. Van Royen and Dr. Wolff, but we do know that Dr. Wolff was at that time not at all associated with aeronautics. He confided in his personal memoirs, made available to the author by his son Ir. W.J. Wolff, that up to that time he had no interest in aeronautics. Dr. Wolff's wrote in his memoirs:

> -*"For me it was difficult. I had not been interested in aeronautics, except that I had read the newspaper articles about the flights of Blériot, Küller and others. I knew Küller from Delft. (Ir. Gijs Küller, a graduate from Delft, carried out the first powered flight in the Netherlands' East Indies - Indonesia - (see Chapter 1). I never attended a flight demonstration, even though Olieslagers had made demonstration flights at Watergraafsmeer (close to Amsterdam). The only thing that had interested me was a toy that my parents brought from their visit to the World Exhibition in Paris in 1889.[2] It was a light rotor,*

[1] In 1905 the Polytechnical School at Delft had been transformed to the Technical University Delft and it became possible to obtain a Doctor's degree in the Technical Sciences in Delft. For a long time this happened very infrequently and between 1905 and 1940 the Department of Mechanical Engineering granted only 25 Doctor's degrees; in fact in 1914 Wolff was the second engineer who obtained a Doctor's degree at that Department, [Ref. 87].
It is interesting to note that Van der Maas (1929), with Prof. J.M. Burgers as promotor, and Van der Neut (1932), with Prof. C.B. Biezeno as promotor, were respectively the 9th and 17th engineer awarded a Doctor's degree at the Department of Mechanical Engineering.

a sort of helicopter rotor, which would lift itself after bringing it in rotation. This proved to be an entertaining toy for the engineers at our laboratory and later also for the children of Van der Maas."

-"In 1901 I brought from Paris for my brother Jan, a Zeppelin model, to be attached to the ceiling and provided with an elastic band driven propeller which would drive it around in circles. On the box it said: "Nouveau jouet aérien, preuvent d'une façon irréfutable que la navigation en ballon n'est pas un utopie, elle ne tient qu'à un fil." Free translation: New toy, proving indisputably that flight in a balloon is not impossible, it is only held up by a shoe string. (Dutch equivalent: "Het hangt slechts aan een zijden draadje").
That was about the extent of my interest in aeronautics. The new position would mean that I would have to become acquainted with a completely new field which seemed exciting, and also that I would be involved in official functions and I was not looking forward to that aspect. I talked to Lies (my wife) and several others and the result was that I accepted the job".

And then he continued:

-"Prof. Van Royen said that it was the intention to establish a temporary laboratory in Amsterdam but after the war it would be moved to Delft. The director would be eligible for a professorship at the University of Delft. I objected, saying that I was not the right person for the more theoretical aspects of aeronautics and that I was interested in the more practical aspects and in applied research. His response was that this would be sorted out later. Ir. P.G. Pigeaud, a recently graduated Electrical Engineer, would join me. He had a good theoretical background and he would provide general assistance. Since Prof. Van Royen wanted to start the preparations immediately, it was agreed that I would begin on 1 January 1918, but that I would stay at Werkspoor till May so that I could at the same time transfer the ongoing business at Werkspoor to my successor".

-"First priority was the design and construction of a wind tunnel similar to the one Eiffel had built in Paris. We started to make plans. The only information we had was a description in Eiffel's book and a publication of an American wind tunnel at M.I.T. (one must remember that there was a war going on and that there was no systematic literature collection on aeronautics in The Netherlands). I had advanced the idea that besides a wind tunnel for aerodynamic testing, we needed installations to study engines and materials. Prof. Van Royen agreed."

-"The Navy made available a building, the so-called 'Old Saw Mill' (de Oude Zaagmolen) at the Navy Yard in Amsterdam. We set up office in an empty building nearby, a former dispensary. Mr. M. Pinke,[3] a designer and Mr. Willemsen, guard and general assistant, were hired and we started to plan

[2]Note that this was the time when Eiffel had built his Eiffel Tower at the entrance of the Exhibition Ground and that from that tower he carried out his drop tests to measure the aerodynamic resistance of various bodies during the period of 1903-1905. It is also interesting to note that this is the site where Eiffel built his first wind tunnel in 1909. In 1912 this tunnel was moved to rue Boileau, in the 16th Arrondissement of Paris, where it is still in operation, [Ref. 88]. Even more interesting is that Dr. Wolff paid a visit to Eiffel's laboratory on Monday 4 August 1919, after the new wind tunnel at the RSL laboratory (of the Eiffel type) had been put into operation.

[3]Mr. Pinke started to work for the RSL on 1 August 1918, first as a designer and later as Head of the calculation and drawing office. On 1 April 1960, after almost 42 years of service, he retired as the last original member of the first RSL team. His son, Mr. M.H.L. Pinke, who retired from NLR more than 25 years later, on 1 January 1986, as Chief of the Administration Department was also a great contributor to the development of NLR. Most employees - if not all - and particularly the project engineers, had very positive experiences with the Administration Department.

the building modifications. The saw mill building was basically an empty shell with thick outer walls, small windows and inside a row of columns."

-"There were problems due to the war-time conditions. For example we had to compromise on the size of the wind tunnel since, due to the fact that copper was scarce, the size of electric motors manufactured in The Netherlands was limited".

-"An interesting detail was that I noted in the Royal Decree of 8 May 1918 in which I was appointed Director, effective 15 April 1918, that I was appointed as Director of the Study Department of the Aeronautical Service. The only Aeronautical Service was at Soesterberg (the Army Air Service). The Navy had of course also started an Air Service but this group was much smaller. So the Defence Department had named us a Study Department of the Air Service at Soesterberg. I drew Prof. Van Royen's attention to this and after some negotiations the name was changed to 'Rijks-studiedienst voor de Luchtvaart', RSL (Government Study Service for Aeronautics)".

-"There was only a small group of people actively concerned with aviation, mostly at Soesterberg (Army) and at De Mok (Navy). They were enthusiasts and dare-devils. Initially this group was alien to me. Also, I had never dealt with the military except for some technical people. There were scores of others I had to meet to become acquainted with the activities and plans of the military, the industry and various other organizations. This was not easy for me since I was rather shy. I was not a hero and I had difficulty to overcome my fears when Pigeaud and I visited De Mok and LTZ. Muller took me on a flight in a hydroplane. That was my first flight on 18 June 1918. It was a beautiful day and I liked it very much. I will never forget the view of Den Helder and the islands".

-"On 12 October 1918 I made my second flight under rather unusual circumstances. The Army at Soesterberg used a trainer[4] with which they were quite pleased. However the performance had never been measured. When I visited Soesterberg that day, we sat at the coffee table and Von Baumhauer, an engineer of Trompenburg (who later joined the RSL) made a bet with Vreeburg, Chief Technical Services at Soesterberg, about the maximum speed at which the airplane could fly. So.....that had to be measured! Versteegh would fly the airplane and I was going to measure the speed in the airplane. Someone else would measure the speed on the ground. We flew several times a trajectory laid out on the ground and I noted the time. At the end of the trajectory we went straight up, turned and then pursued the trajectory in the other direction. I do not remember what the speed was and who won the bet but it was a very fine experience."

These are some of the early experiences of Dr. Wolff. Very rapidly he became acquainted with aeronautics. He took up contact with aeronautical engineers and scientist in other countries as soon as the war was over. He visited other countries and promoted exchange of ideas as much as was possible and he helped organize several international congresses which were landmarks in the international scientific development, i.a. the first International Congress of Applied Mechanics (Delft, 1924) and the Congress for Materials Testing (1927). For this he was awarded the Daniel Guggenheim Medal of the American Society of Mechanical Engineers.
Nationally he was a co-founder of the Institute of Materials Research and the Society of Materials (Bond voor Materialenkennis) of which he was an Honorary Member, and he was often consulted

[4]The airplane was probably a Trompenburg V-2. The Army had ordered 58 and the Navy had ordered 20 airplanes of this type. Von Baumhauer was Chief Engineer at Trompenburg.

in matters concerned with research and industrial development, such as the Patent Council and the organization of TNO (the Netherlands Organization for Applied Scientific Research).

In the 1920's and the 1930's he managed to bring the laboratory up to an international level as is clear from this book. His own scientific contributions were of great importance and stimulated the RSL/NLL-personnel.

Although he was not a pilot himself, he recognized the **scientific value of flight testing** to complement the theoretical and experimental investigations in the laboratory. This distinguished him from the leaders of several other aeronautical laboratories.

Dr. Wolff demanded from his researchers full and precise documentation of their work and he stimulated them to publish their results. Much later Prof. Van der Maas told the author about the stimulating guidance he received from Dr. Wolff when he worked at the RSL/NLL (1923-1940). Dr. Wolff insisted on accurate flight testing and reporting.

On the occasion of the transition of the Government Service RSL to the Foundation NLL in 1937 Dr. Wolff was appointed 'Ridder in de Orde van de Nederlandse Leeuw' (Knight of the Order of the Netherlands' Lion).

In 1939 Dr. Wolff was elected Fellow of the Institute of the Aeronautical Sciences, IAS (now the American Institute of Aeronautics and Astronautics, the AIAA). That Institute had been founded in 1932 and in 1934 at the first Annual Meeting 23 Fellows were elected. Thereafter one Fellow was elected for every 1,000 voting members. Dr. Wolff belonged to the very first foreign members elected as Fellow of the IAS and the laboratory considered this as a sign of international recognition.

In December 1939 Dr. Wolff had to take extended sick leave. His health had been deteriorating and on 1 August 1940 he resigned from the post he had held from the very beginning of the RSL in 1918. On 7 February 1941 Dr. Wolff passed away. To honor this sympathetic first Director a plaque was placed in the laboratory in Amsterdam.

Prof. Dr. Ir. H.J. van der Maas

(19 October 1899 - 24 February 1987)

Hendricus Jacobus van der Maas was born 19 October 1899, Amsterdam. He was confronted with special responsibilities at a very early age. He lost his father when he was eight years old and, as the eldest of three sons of whom the last one was born after his father died, he supported his mother in running the store and the household. The strong protestant faith of the family was a great source of inspiration and this remained so for Van der Maas throughout his whole life. The family had a hard time financially and the eldest son started his education close to home in Amsterdam. But after completing the Mulo-B (at that time an intermediate secondary school) and the MTS (which was a Technical College) in Amsterdam and having obtained exceptionally high grades, he did go to the Technical University Delft. Although he had of necessity taken the long road, he was awarded the 'Ingenieur's Diploma' in Nautical Engineering (Scheepsbouwkundig Ingenieur) in June 1923 at the age of 23.

On 16 October 1923 Ir. Van der Maas started to work at the RSL. He received a pilot training at Soesterberg and became, after Ir. Grasé, the second engineer who was also a pilot. At Soesterberg, the Army Air Base, they were given the rank of 1st Lieutenant Special Services.

On 26 April 1925 he married Hendrica Suk with whom he shared more than 50 years of his life. With their twelve children they built up a unique family life which they shared with many relatives and friends. Later, after Van der Maas became Professor of Aeronautical Engineering at Delft, he and his wife often had Open House, particularly for the first year students and Prof. Van der Maas

Prof. Dr. Ir. H.J. van der Maas, 1899-1987

personally inspired them during their often difficult transition from high school pupils to university students.

As indicated above Dr. Wolff saw the need for objective flight performance measurements and the establishment of quantitative performance and control criteria. He found in Ir. Van der Maas the right person to develop these. As indicated in Chapter 6, he carried out an enormous number of flight tests, often as pilot and sometimes as an observer. Many of these flight tests on aircraft of national and foreign manufacturers, were ordered by the Army Air Force, the Navy Air Service, KLM, KNILM, Fokker, Koolhoven, Pander, Van Berkel, Spijker and De Schelde.

His studies and experiments in the area of stability and control led to a dissertation for which he was awarded the degree of Doctor in the Technical Sciences at the Technical University Delft in 1929; Prof. Burgers was his promotor, (see also Chapter 6).

The RSL was initially charged with the issuing of airworthiness certificates and Dr. Van der Maas was appointed 'Rijksvlieger' (Government Pilot) to make the final judgement on flight safety. When in 1930 (see Chapter 3) the formal responsibility for the airworthiness aspects was transferred to the Department of Civil Aviation, the situation did not change materially since the actual technical knowledge and experience was concentrated at the RSL.

In the 1920's and the 1930's flight testing was particularly difficult since one had not only to devise the methods of measuring the flight properties but one also had to develop the instrumentation. There was almost no flight test instrumentation on the market. The development time of new aircraft was very short and the judgement of the flight characteristics was a difficult task. The aircraft often had to be tested to extreme conditions. This also meant that flight testing for certification was not without danger as for example the determination of the stall properties of aircraft (a phenomenon not always understood by the designers) and the recovery from a spinning motion. Also there were often substantial differences in performance between aircraft of the same type.

Dr. Van der Maas became very devoted to this profession of engineer-pilot and in his later years he would tell enthusiastic stories about this period and he would recall the great influence Dr. Wolff had on him. Dr. Wolff was very demanding and expected from him the very best. He wanted honest and straight-forward reporting. *"If you don't write it down you might as well not have done it"*. Dr. Wolff supported him as much as he could with the limited means available.

Most of his work did not receive much publicity. An exception was the accident with the 'Uiver', a Douglas DC-2, when it crashed during the night of 19-20 December 1934 in a thunderstorm near Rutbah Wells in what is now Iraq, halfway between Gaza (Israel) and Bagdad. The aircraft, with a four men crew and three passengers, made its second flight from Amsterdam to Batavia (Jakarta) and carried 51,000 Christmas letters for the Netherlands' East Indies. This aircraft had been bought by KLM earlier that year and it had participated in the race from London to Melbourne, Australia (the MacPherson Robertson Race), in October 1934. The 'Uiver' received the first prize in the handicap race and this event had received enormous publicity in The Netherlands. The fatal accident of this famous aircraft, only a few months later, and the fact that Fokker, who had a competing passenger aircraft (the F36) under development, was losing ground with KLM, made that the accident investigation drew much publicity. It was Dr. Van der Maas who was sent to Iraq to carry out the accident investigation for the government. He returned on 3 January 1935 and the newspapers began to carry stories suggesting that in his opinion the aircraft was not safe to fly under extreme weather conditions. The results of the investigations were published six months later. The major cause identified was the extremely bad weather condition. This combined with the limited experience with this type of aircraft under these conditions and probably reduced directional stability under heavy gust conditions was fatal for the 'Uiver'. It must have been difficult for Dr. Van der Maas to be exposed to that much publicity while he was trying to sort out the real problems encountered with this aircraft.[5]

In 1937 and again in 1939 he travelled to the USA in connection with the acceptance of American aircraft. During those rather long trips he made several contacts which later, during the late 1940's and the 1950's when trans-Atlantic travel became more common, were important for the development of aeronautics in The Netherlands.

On 6 May 1940, a few days before the war started in The Netherlands, he was appointed as the first full-time Professor of Aeronautical Engineering at the Technical University Delft. After he left the laboratory he became an Advisor to NLL.

The progress at the university was slow during the war years. Prof. Van der Maas was active in the resistance and at some point he had to go into hiding. During this period he was occupied by resistance matters, but he must also have studied practically all the scientific aeronautical literature that was available to him and he prepared the aeronautical curriculum. This was very useful for the university but also for NLL. Immediately after the war he held the position of Rector (President) of the university during the academic year 1945-1946. He started a full aeronautical engineering course at a high international level. The staff was expanded and educational and research facilities were built up within a short time. He held the position of Chairman of the Department of Aeronautical Engineering till his retirement from the University in 1967.

The result of all this was a flourishing Aeronautical - later Aerospace - Engineering Department with now close to 2,000 graduates. Prof. Van der Maas' enthusiasm and drive stimulated his staff and students in an unprecedented manner.

The reconstruction of the aircraft industry in The Netherlands was supported by the Government through the Netherlands Institute for Aircraft Development - the NIV - which was founded in 1946, (see Chapter 5). Prof. Van der Maas became the first Chairman of the Board of NIV, a position he held till 1970. This Foundation has the task to stimulate aircraft development in The Netherlands. Through this institute aeronautical research projects are funded and a special revolving fund was established to finance the development of aircraft projects. In 1971 the task of NIV was expanded to include space research and development programs and the name of the Institute was changed into the Netherlands Agency for Aerospace Programmes (NIVR). This unique institute drew the attention of many, at home and abroad.

On 27 December 1950 Prof. Van der Maas was also appointed Chairman of the Board of NLL. As described in Chapter 5, this was a very critical period for the laboratory. There is little doubt that it was through Prof. Van der Maas' drive and conviction that NLL won the trust and support of the Government.

Anyone who met him during that period was impressed by his enormous enthusiasm, his extra-ordinary capacity to tackle many jobs at the same time and his fore-sight. Prof. J. Singer of Technion, Haifa, Israel, told the following story. He had asked Prof. Van der Maas: *"Should we as small nations have an aeronautical industry? Is this not a hazardous undertaking?"* He said that Prof. Van der Maas had only answered: *"The whole of Holland is a hazardous project!"*

[5]The Annual Report of the RSL of the year 1934 states:
-*"In connection with the purchase order of Douglas aircraft, the Director (of the RSL) received an order from the Inspector of Aviation to visit Washington and Santa Monica in order to gain an impression of the official flight safety control and of the details of the Douglas aircraft designs."*
The departure of the RSL party was planned on 22 December 1934, but had to be postponed in connection with the 'Uiver' accident. It did take place in 1935 and the Annual Report of that year states:
-*"In connection with the KLM purchase of DC-2 aircraft, Dr. Wolff, the Inspector of Aviation Mr. Van der Heyden and Dr. Van der Neut paid a visit to the USA. They had discussions with the American aeronautical authorities and with leading personnel of Douglas ... At our instigation Douglas introduced a number of modifications in the construction of the aircraft. Some restrictions for flight under bad weather conditions were proposed.*
That aircraft, the DC-2, its successor the DC-3 and the military version known as the 'Dakota' became very popular in The Netherlands (as everywhere else).

It is now almost unthinkable in The Netherlands that one person could simultaneously hold the three functions: Chairman of the Department of Aerospace Engineering of the Technical University Delft, Chairman of the Board of NIVR and Chairman of the Board of NLR.
It was a dominating position and it seemed sometimes that the combination of these three positions in one person could lead towards compromising situations. However, he managed to separate these functions very well. He definitely did not pride himself on his achievements. To him it was a 'calling', almost in a religious sense.

During the 1960's Prof. Van der Maas stimulated the space activities in The Netherlands, and in particular he participated in the Geophysics and Space Research Committee of the Royal Academy of Sciences of which he was elected Member in 1959. There he emphasized especially the important link between space research and technology and aeronautical engineering.

Prof. Van der Maas was a Founder Member of AGARD and he served on the National Delegates Board of AGARD from 1952 till 1971. For his contributions to AGARD he was awarded the Von Kármán Medal in 1973.

He was also a Founder and Life Member of the International Council of the Aeronautical Sciences - ICAS - a world wide Council, founded in 1957 after Harry Guggenheim, a distinguished American industrialist and philanthropist called together leading aeronautical scientists from various countries on the occasion of the annual meeting of the Institute of the Aeronautical Sciences, the IAS, on 29 January in New York. Guggenheim made a donation to support the initial secretarial activities carried out by the IAS. ICAS brings together the aeronautical societies of the world. The first presidents of ICAS were Prof. M. Roy of France and Dr. Von Kármán of the USA, then Chairman of AGARD.

Prof. Van der Maas represented the aeronautical scientific community in the world through AGARD, ICAS and other, less formal, associations. He was very much appreciated by his colleagues abroad and the laboratory benefited very much from the international relations he maintained.

Nationally his contributions were recognized on several occasions. He was the recipient of the Gen. Snijders Medal of the Royal Netherlands Aeronautical Society, the KNVvL. (Gen. Snijders was the great promoter of aeronautics in The Netherlands and he suggested the formation of the RSL, Chapter 2). Prof. Van der Maas was Commandeur in de Orde van Oranje-Nassau (Commander of the Order of Orange-Nassau) and Ridder in de Orde van de Nederlandse Leeuw (Knight of the Order of the Netherlands' Lion).

During the impressive period of $47\frac{1}{2}$ years - from 16 October 1923 till 7 May 1971 - he served the RSL/NLL/NLR-organization. His love and his enthusiasm for the aerospace engineering profession stimulated many hundreds of people who worked with him closely over this long period.

Prof. Van der Maas retired from the Technical University Delft in 1967, from the Board of NIVR in 1970 and from the Board of NLR in 1971.

After his retirement of the last official function in 1971 he spent only a few quiet years with his wife, till she passed away in 1975. Prof. Van der Maas died on 24 February 1987.

About the Author

The author, Jan A. van der Bliek (1928), studied Aeronautical Engineering at the Technical University Delft, 1946-1953. During 1951-1953 he worked for two years on Low Speed Wind Tunnels at Ottawa, Canada and at Delft, The Netherlands.

After he received his Ingenieur's Diploma in 1953, he became a Research Officer at the High Speed Aerodynamics Laboratory of the National Research Council (National Aeronautical Establishment), Ottawa, Ont., Canada.

In 1959 he was employed by ARO, Inc. (now Sverdrup Technology) in the Hypervelocity Branch of the Von Karman Facility of the USAF Arnold Engineering Development Center (AEDC), Tullahoma, Tenn., USA.
During the academic year 1963-1964 he served as Visiting Professor (with an ARO Grant) at the Von Karman Institute, Brussels, Belgium.
After having returned to the USA, he worked in the Aerospace Environmental Facility of the AEDC.

In 1967 he moved to The Netherlands where he headed the Space Activities at NLR, till he was appointed Deputy Director of NLR in 1971.
When the General Director, Ir. A.J. Marx, retired in 1976, he succeeded him in that position.

For three years (1988-1991) he held the position of Director of AGARD, an agency of NATO located at Paris, France.

In 1991 he became Professor and Dean of the Department of Mechanical Engineering of the University Twente, Enschede, The Netherlands - and also a Consultant to NLR.

In 1986 he was appointed Officier in de Orde van Oranje-Nassau (Officer of the Order of Orange-Nassau).
In 1983 he was elected Foreign Member of the Royal Swedish Academy of Engineering Sciences (IVA).
In 1990 he was elected Fellow of the American Institute of Aeronautics and Astronautics (AIAA) "for outstanding performance in the management of aerospace research in Holland, Canada and the United States, and for fostering cooperation through numerous international organizations".

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Abbreviations

AIAA	American Institute of Aeronautics and Astronautics
AGARD	Advisory Group for Aerospace Research and Development
AICMA	Association Internationale des Constructeurs de Matérial Aéronautique
AECMA	Association Européenne des Constructeurs de Matérial Aérospatiale (Association of European Aerospace Material Manufacturers)
ANS	Astronomical Netherlands Satellite
ARALL	Aramide Aluminum Laminate
ATC	Air Traffic Control
AVA	Aerodynamische Versuchsanstalt (Göttingen), now part of DLR
BDM	Blackstone-Damme-Van der Maas (report)
BPPT	Badan Pengkajian Dan Penerapan Teknologi (Agency for the Assessment and Application of Technology, Indonesia)
CAE	Canadian Aviation Electronics/Computer Aided Engineering
CFD	Computational Fluid Dynamics
CFRP	Carbon Fiber Re-inforced Plastics
CIPS	Comité Internationale Permanent des Souffleries (part of AECMA)
CSST	Continuous Supersonic Wind Tunnel
CTOL	Conventional Take-off and Landing
DFVLR/DLR	Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Germany, now abbreviated as DLR (German Aerospace Research Institute)
DGL	Dutch Guilder
DNW	Deutsch-Niederländischer Windkanal/Duits-Nederlandse Windtunnel (German-Dutch Wind Tunnel)
DRA	Defence Research Agency, UK, (includes the former RAE)
DRG	Defence Research Group (an Agency of NATO)
EC	European Community/European Union
ELDO	European Launcher Development Organisation
ELTA	Eerste Luchtverkeer Tentoonstelling Amsterdam (First Aviation Exhibition Amsterdam)
ESA	European Space Agency
ESRO	European Space Research Organisation
ETW	European Transonic Windtunnel
GARTEUR	Group for Aeronautical Research and Technology in Europe
GigaFlop	One thousand million floating point operations per second
GUK	Grosser Unterschall Kanal
HA	Hectare, 100 meter x 100 meter
HP	Horse Power
HSA	Hollandse Signaal Apparatenfabriek (Signaal)
HST	High Speed Wind Tunnel
IAI	Israel Aircraft Industry
ICAF	International Committee on Aeronautical Fatigue
ICAS	International Council of the Aeronautical Sciences
IEPG	Independent European Programme Group (of NATO)
IPTN	Industri Pesawat Terbang Nusantara (formerly Nurtanio),Bandung
IRAS	Infra-Red Astronomical Satellite
ISNaS	Information System Navier-Stokes equations
ITB	Institut Teknologi Bandung (Indonesia)
kHz	Kilo-Hertz
KIvI	Koninklijk Instituut van Ingenieurs (Royal Institute of Engineers)
KLM	Koninklijke Luchtvaart Maatschappij (Royal Dutch Airlines)
KLu	Koninklijke Luchtmacht (Royal Netherlands Air Force, RNLAF)
KM	Koninklijke Marine (Royal Netherlands Navy, RNLN)
KNILM	Koninklijke Nederlandsch-Indische Luchtvaart Maatschappij (Royal Dutch East Indies Airline)

KNMI	Koninklijk Nederlands Meteorologisch Instituut (Royal Netherlands Meteorological Institute)
KNVvL	Koninklijke Nederlandse Vereniging voor Luchtvaart (Royal Netherlands Aeronautical Society)
KTH	Kungl. Tekniska Högskolan (Royal Institute of Technology, Stockholm)
LSK	Luchtstrijdkrachten (Dutch Air Force before it became the KLu)
LST	Low Speed Wind Tunnel
LVA	Luchtvaartafdeling (Air Force, Department of the Army)
MARIN	Maritiem Research Instituut Nederland (Netherlands Maritime Research Institute)
MBB	Messerschmitt-Bölkow-Blohm
MegaByte	One million bytes (characters)
MLD	Marine Luchtvaartdienst (Naval Air Service)
MLS	Microwave Landing System
M,m	Meter
MW	MegaWatt
NACA	National Advisory Committee for Aeronautics (USA)
NARSIM	NLR Air Traffic Control Simulator
NASA	National Aeronautics and Space Administration (USA)
NATO	North Atlantic Treaty Organisation
NHI	Nederlandse Helikopter Industrie (Dutch Helicopter Industry)
NIV/NIVR	Nederlands Instituut voor Vliegtuigontwikkeling/Nederlands Instituut voor Vliegtuigontwikkeling en Ruimtevaart (Netherlands Agency for Aerospace Programs)
NIWARS	Nederlandse Interdepartementale Werkgemeenschap voor het Applicatieonderzoek van Remote Sensing Technieken (Netherlands Interdepartmental Working Group for the Application of Remote Sensing Techniques)
NLL	Nationaal Luchtvaartlaboratorium (National Aeronautical Laboratory)
NLR	Nationaal Lucht- en Ruimtevaartlaboratorium (National Aerospace Laboratory)
NOP	Noordoostpolder
NPL	National Physical Laboratory (UK)
NSF	National (Flight) Simulation Facility
OMIS	Operational Management Information System at Air Base Level
ONERA	Office National d'Études et de Recherches Aérospatiales (French Aerospace Research Institute)
PHST	Pilot High Speed Wind Tunnel
PTT	Post, Telegraaf en Telefoon (Postal and Telecommunication Services)
RAE	Royal Aircraft/Aerospace Establishment (British Aerospace Research Institute)
RLD	Rijksluchtvaartdienst (Government Department of Civil Aviation)
RNLAF	Royal Netherlands Air Force
RNLN	Royal Netherlands Navy
RSL	Rijks-Studiedienst voor de Luchtvaart (Government Service for Aeronautical Studies)
SOBEH	Stichting tot Ontwikkeling en Beheer van een Experimenteel Hefschroefvliegtuig (Foundation for the Development and Construction of an Experimental Helicopter)
SST	Supersonic Wind Tunnel
SST	Supersonic Transport Aircraft
TDCK	Technisch Documentatie Centrum voor de Krijgsmacht (Technical Documentation Center for the Armed Forces
TNO	Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek (Netherlands Organization for Applied Scientific Research)
TPS	Turbo-Powered Engine Simulator (Wind Tunnel Model Engine)
TUD	Technical University Delft/Delft University of Technology (DUT)
USAF	United States Air Force
UV	Ultra-violet
V/STOL	Vertical and Short (or Steep) Take-off and Landing
VFW	Vereinigte Flugtechnische Werke (German Aircraft Company)
VKI	Von Karman Institute (Belgium)

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Note: Names of persons starting with the prepositions Van, Von, De, etc. are listed under the main name.

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