COST

COST FORUM

Transnational Cooperation in Science and Technology with new European Partners

Vienna, 22 November 1991

Commission of the European Communities

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science
and technology policy

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Proceedings

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COST

Exhibition

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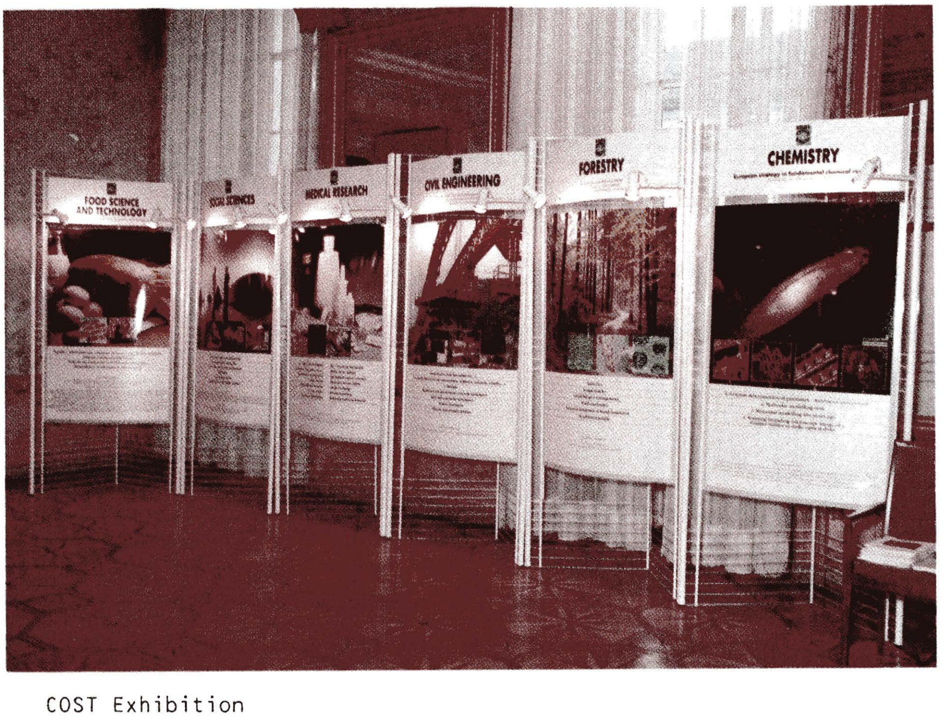

COST Exhibition

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TRANSNATIONAL COOPERATION IN SCIENCE AND TECHNOLOGY

WITH

NEW EUROPEAN PARTNERS

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PROGRAMME OF THE FORUM

9 a.m.	Opening of the COST Forum Introductory remarks by: **R. KNEUCKER** (Director General for International Relations, Federal Ministry for Science and Research, Vienna, Austria) **N. ROULET** (Chairman of the COST Senior Officials Committee, Switzerland) **P. FASELLA** (Director General for Science, Research and Development, Commission of the European Communities)
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1. Telecommunications

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J. M. DWYER
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J. EKBERG (Technical Research Centre of Finland, Espoo, Finland)
Basis of COST telecommunications cooperation on networks

During this workshop, 10 different topics are being presented by various speakers.

2. Transport

Workshop Chairman: **M. J. DE BOCK** (Chairman of the technical committee "Transport", Ministry of Transport, The Hague, Netherlands)

T. DAVIES (University of Wales, Cardiff, UK)
H. VAN MAAREN (CETIMA Consultancy, Netherlands)
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M. TOFT (Ministry of Transport, Copenhagen, Denmark)
Improvement of urban transport: LRT systems (tramways, trolleybuses, light metro, ...)

3.Forestry and Forestry Products

Workshop Chairman: **J. F. LACAZE** (Chairman of the technical committee "Forest and Forestry Products", Institut National de la Recherche Agronomique, Orléans-Olivet, France)

D. NOACK (Bundesforschungsanstalt für Forst- und Holzwirtschaft, Hamburg, Germany)
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Atmospheric pollution by photooxidents over Europe

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Achievements in the field of ecological effects of air pollution on terrestrial and aquatic ecosystems

12.45 p.m. Press Conference by the chairmen of the technical committees

1 p.m. Luncheon for Forum participants

2.30 p.m. Continuation of workshop sessions on the four areas as above.

In addition, simultaneous workshop sessions on:

5. Chemistry

Workshop Chairman: **G. BALAVOINE** (Chairman of the technical committee "Chemistry")

6. Social Sciences

Workshop Chairman: **B. ÖHNGREN** (Chairman of the technical committee "Social Sciences")

7. Meteorology

Workshop Chairman: **B. McWILLIAMS** (Chairman of the technical committee "Meteorology", Meteorological Service, Dublin, Ireland)

8. Materials

Workshop Chairman: **E. SEITZ** (Chairman of the technical committee "Materials", Forschungszentrum Jülich GmbH (KFA), Germany

5 p.m. Closing session

Brief reports from the Workshops and concluding remarks

6 p.m. End of the Forum

During the Forum, an exhibition on COST activities including posters, publications and demonstrations of various installations resulting from COST work will give an overview about COST research areas and the most important COST projects.

A demonstration of the COST data base will allow interested parties to collect data about project participants and people to contact as well as detailed project descriptions.

C. OPENING SESSION

Opening of the COST Forum (from the left to the right: R. KNEUCKER, Austrian Ministry for Science and Research, N. ROULET, Chairman of COST Senior Officials, H. TENT, Commission of the European Communities

Attendance of the COST Forum

N. ROULET (Chairman of the COST Senior Officials)

C'est un grand honneur pour nous et un plaisir d'ouvrir ce forum scientifique, d'une part à l'occasion du vingtième anniversaire de COST, et, d'autre part à l'occasion de l'élargissement de COST à quatre nouveaux Etats - l'Islande, la Hongrie, la Pologne et la Tchécoslovaquie.

Nous avons pensé qu'il est extrêmement important d'amorcer cette nouvelle étape de la collaboration scientifique européenne en donnant l'occasion aux scientifiques actifs dans les différentes actions COST d'avoir avec leurs futurs partenaires scientifiques des nouveaux pays un dialogue interactif intense.

Le but de ce forum est précisément de réaliser cette possibilité de rencontre afin de préparer les scientifiques des nouveaux pays membres de COST et aussi de préparer l'ensemble des scientifiques responsables des actions COST en marche à cette nouvelle évolution, et enfin préparer le terrain pour la mise en oeuvre des futures activités scientifiques.

Il est extrêmement important aussi de pouvoir dès maintenant commencer ce dialogue non seulement sur les recherches qui sont en cours, mais aussi sur celles qui sont en préparation. Parce qu'effectivement, dans ces recherches qui sont en préparation il est beaucoup plus facile pour les nouvelles équipes de s'intégrer dans ce nouveau "train", ou même de contribuer à la définition des objectifs; ils auront plus de temps aussi pour effectuer les préparatifs nécessaires pour entrer dans ces nouvelles démarches scientifiques d'actions concertées.
Nous avons pensé qu'il serait utile, à l'occasion de ce workshop, que dans chaque domaine soient déjà identifiées des collaborations possibles, les intérêts des nouveaux instituts et les problèmes qui ne manqueront pas de se présenter, d'ordre scientifique ou administratif.

Nous pensons à la fin de cette journée, avec les remarques générales et puis les conclusions, pouvoir obtenir une vue d'ensemble de ce qui aura été amorcé et aussi avoir une idée assez précise des problèmes que nous devrons surmonter les prochains mois et les prochaines années. J'achève de cette manière les remarques générales et je passe la parole à M. Kneucker.

R. KNEUCKER (Director General for International Relations; Federal Ministry for Science and Research, Vienna, Austria)

Meine Damen und Herren!

Dem Stil der Organisation und der Tradition von COST entspricht es, daß die Wissenschaftler Gelegenheit haben, bei Veranstaltungen und Aktionen einen direkten Kontakt herzustellen. Das ist der Vorgangsweise der Forschung angemessen, die auf persönlichen, direkten, wissenschaftlichen Kontakten beruht. Es ist besonders angemessen in einer Zeit, in der neue Mitglieder in die COST-Organisation integriert werden sollen. Es geht um autonome, wissenschaftliche Initiativen für eine gemeinsame europäische Kooperation.
Und für die neuen Mitglieder, die wir gestern aufgenommen haben, gilt, woran ich mich als Österreicher besonders gut erinnere, als wir COST beigetreten sind. Es war das Übungsfeld und die Gelegenheit, in ein größeres Europa integriert zu werden, wofür wir der COST Organisation und den europäischen Partnern besonders dankbar sind bis auf den heutigen Tag.

Ich möchte nun das Wort an Herrn Tent weitergeben.

H. TENT (Deputy Director General for Science, Research and Development, Commission of the European Communities)

Thank you, Mr. Chairman!

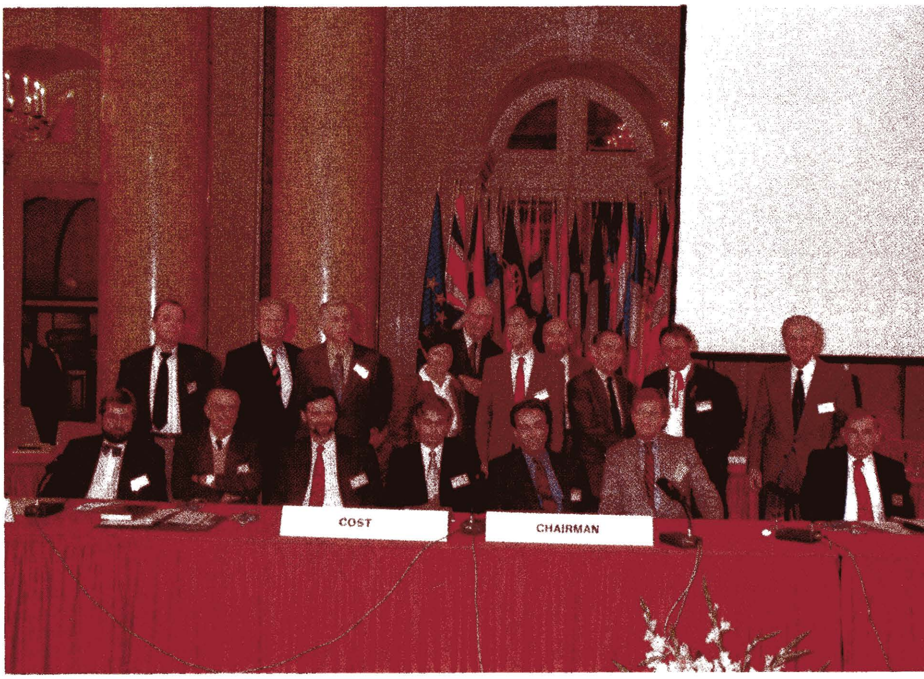
Mr. Chairman, first I would like to excuse for my Director General, Mr. Fasella, not being here today, but he was called back to Brussels. It is my pleasure to be here, because I also was in Reading, in 1988, an occasion that was to a certain extent similar to what we are doing today. Then I had a speech written for me as today, a very well written speech, but after I have heard a number of interventions of the chairmen of projects and workshops, I was taken back, I must say in 1988, by the pessimistic tone of these interventions. So I had to rewrite my speech.

In conclusion my speech came down to the fact that I tried to explain that COST looked like a mother, a mother who married in 1971. Ministers were attending the wedding and everything was OK. But in 1988, she was complaining because her children had left home. Full of esprit, looking BRITE, shouting EUREKA, they left her and they never came to visit her again. So what was left to her - nothing. My advice to mother was to go out, take dancing lessons, see to remarry again, anyhow stop complaining. I won't say that this has influenced the future of COST, but nevertheless I think after 1988 you have done very well. I am not surprised, because finally through COST, EUREKA, CERN, European Space Agency and, if I may say, the progress of the European Community, I think we have created in Europe a community in science and technology on European level. And I think in 1988 COST jumped on the band waggon and we are here today to discuss the results of what happened since then. I think, Mr. Chairman, it also creates new responsibilities, almost a luxury problem, "problème de grandeur".

We have a number of developments in Europe. I won't go into all the details, I think that hopefully within a little more than one year the EFTA countries will fully participate in the Framework Programme of the Community, moreover our programmes will be gradually opened for those European countries who are not member of the Community and in particular those countries who have become member of COST - Poland, Hungary and Czechoslovakia. These are all trends, which are further shaping a real European science and technology community in a very broad sense. And finally, we have to ensure a coordination between the various activities to make sure that the scarce financial and intellectual resource we have in Europe are really used in the most efficient and the best way. It is necessary to do it on the top down level, ministerial level, level of high officials, but also important, Mr. Chairman, is the coordination by the "bottom up" approach, on the "work floor". That is what we are for here today.
I may just briefly remind you that coordination has to start on national level.
It also would mean, that COST, and that's why I used the expression of a luxury problem, has to reflect over how to, promote selectivity and, how to make choices between possible initiatives, without in any way affecting the "bottom up" approach and the flexibility of the initiative. But priorities have to be set.

I have already mentioned the participation of in particular Poland, Hungary and Czechoslovakia in COST and the Commission welcomes this very much. Also, as I reminded you, we are gradually opening our programmes for these and other countries. In my view it is the common responsibility of COST, of the European Community and of EUREKA to ensure that this integration goes as efficient and as quickly as possible. I am not underestimating the difficulties in adapting to the procedures of these various actions. But, I can assure you that even for EFTA countries it took considerable time before they were able to participate fully in programmes of the Community. So don't be discouraged, we are ready to give you any help that is necessary for the Commission sees it as its responsability to help to maintain the scientific and technological basis in the countries of Central and Eastern Europe.

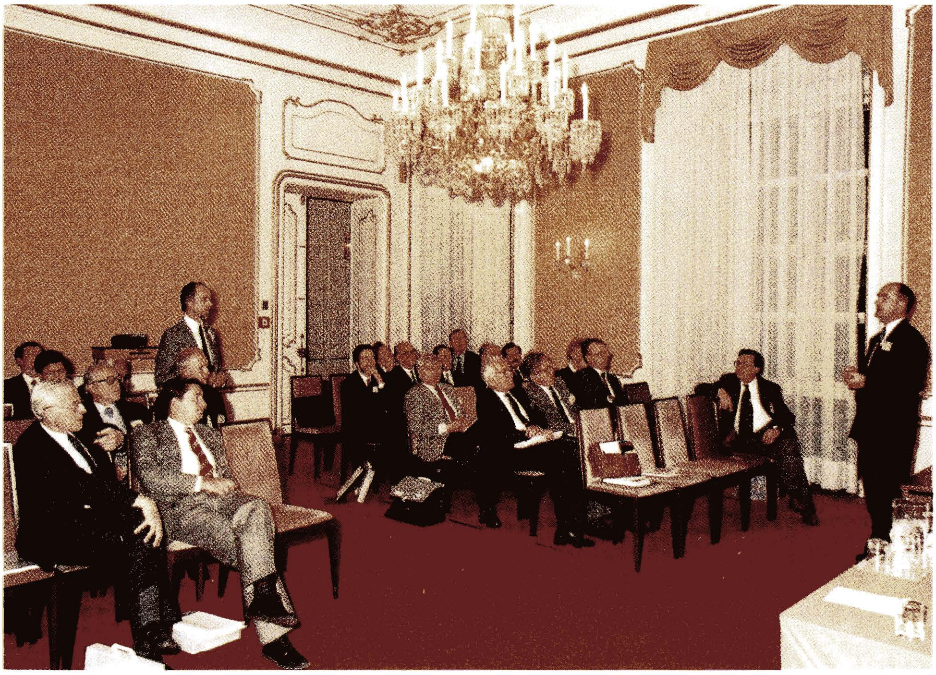
Mr. Chairman, you know the committment of the Commission to COST, you know that we have supported COST since the beginning, and I would ensure you that we will continue to do so.
Thank you so much.



Chairmen and Secretaries of Technical Committees

Chairmen of Technical Committees

D. CHEMISTRY



Workshop "Chemistry"

CHEMISTRY : a science at the crossroads of numerous human activities. Importance of international cooperation in fundamental chemical research.

Gilbert BALAVOINE
(Centre National de la Recherche Scientifique - Paris, FRANCE -)

Chemistry is a fundamental science the objective of which is, on the one hand understanding the laws governing the behaviour and the transformations of matter at the atomic and molecular level and, on the other hand, controlling the transformations allowing thus to create and to invent new chemical species and atomic or molecular constructs.

These general problem aspects puts chemistry into a central position with regard to other sciences, and the interfaces with these other disciplines are often the space of major discoveries (physics, biology, medicine, ...). Chemistry is also an industry being at the centre of numerous human and economic activities. Most of the materials used in manufacturing industries are prepared or transformed by chemical methods. One could say that chemistry, which is a supplier of multisectoral technologies to many other industries, is indeed "the industry of the industries".

A report from the European Communities on "The State of Science and Technology in Europe" states that :

"The Chemical Industry has been one of the most important factors in economic development and social changes that have taken place in Western Europe over the last 30 years. This is an intrinsically innovative sector characterized by the manufacture of new products and materials which integrates with and replaces natural ones calling for different processes and technologies from those known hitherto".

Chemistry plays an essential role in developing high-technology products, in agrochemistry, biotechnology, pharmacy, for information technology and advanced materials.

The problems linked to the environment and pollution are and continue to be solved with the help of chemistry and of chemists.

Fundamental research in chemistry has to be strongly promoted. This is vital for chemistry itself but also for other disciplines the progress and innovations of which depend on conceptual and methodological contributions of chemistry. It is on this line, that the chemical industry pronounced itself on several occasions in favour of its preferences

- to continue to finance their research on the basis of their sales figures, a perfectly dynamical position in a market economy perspective ;

- to orient public money, mainly, if not entirely to fundamental research, the interest of the chemical industry focusing on the preoccupation, that universities supply to the industry young chemists trained through top quality research.

The strong interactions between fundamental chemistry and other sciences and technologies, between the chemical industry and other industries have as a consequence to reduce sometimes the time needed to transform a fundamental result in chemistry into its industrial application. In other words, passing from pre-competitive research to a competitive activity is sometimes very rapid. One has to note that important means are given to promote research in technological areas. One could quote as examples European programmes such as ESPRIT, RACE, BRITE-EURAM, BCR, ECLAIR, FLAIR, BRIDGE, EUREKA... Contrary to that, the programmes promoting fundamental research in the framework of international cooperation, such as the programme SCIENCE, allowed only very partially to respond to the very pronounced demand to cooperate on an intra-community or an intra-European level in fundamental research, particularly in chemistry. One should notice in particular that for the SCIENCE programme the rule was that the programme "does not pursue sectoral objectives through targeted research ; its goal is to increase qualitatively and quantitatively the human resources in research and technological development across the board so as to satisfy the expected needs of the Member States in the coming years".

It is urgent to proceed, in Europe, towards a reflection with regard to the elaboration of a strategic scientific scheme for fundamental research in chemistry. Taking into account the importance of European chemistry on the economic level, it is appropriate to develop this reflection in the perspective of implementing an important concertation and cooperation action in a European dimension.

COST actions are perfectly adapted to this objective and the technical "ad hoc" chemistry committee has decided to contribute in the framework of its mandate, to the elaboration of a strategy for a European action in the area of fundamental research in chemistry. Indeed, and also in the view of the Senior Officials Committee COST, chemistry has been the step-child of R+D efforts in the Community framework. The analysis of the area of chemical science led the technical "ad hoc" committee on chemistry to identify 7 themes for which one should agree rapidly on an important effort of cooperation actions over the coming years.

The 7 themes chosen now will be described in the next lecture by B. Smestad Paulsen. These 7 themes are the following :

A. Coordination Chemistry in the context of biological and environmental studies.

B. Selective Synthesis.

C. Theory and modelling of chemical systems and processes.

D. Design and preparation of new molecular systems with unconventional electrical, optical and magnetic properties.

E. Chemistry at surfaces and interfaces.

F. Chemical processes and reactions under extreme or non-classic conditions.

G. Molecular recognition chemistry.

The 7 themes retained cover only a part of the area of chemistry and represent a first selection. The technical "ad hoc" committee on chemistry intends to pursue the reflection, in the framework of its prolonged mandate, in order to extend its proposals to other themes, notably in the interfaces with biology and physics.

These initiatives have to be considered as the starting thrust for a European policy action for fundamental research in chemistry, which should help to optimize a blossoming synergy among our European countries in fundamental chemical research.

OPTIONS AND STRATEGIC CHOICES FOR FUNDAMENTAL CHEMICAL RESEARCH IN EUROPE.

Berit Smestad Paulsen, Norway.

Chemistry plays, and always has played, an important role in development of a series of important products for mankind. Chemistry is essential in agriculture, biotechnology, pharmacy, development of advanced materials e.g. for information technology and for problems concerned with the environment and pollution. The COST comittee in chemistry has identified 7 topics which should be the goal for special effort in fundament research in chemistry in Europe in the near future in order to achieve necessary fundamental knowledge for solving the problems in volved in the different areas.

The 7 topics chosen will be presented in the rest of the article.

A. Coordination Chemistry in the context of biological and environmental studies. Coordinator: Prof. J.Reedijk, Leiden, NL.

In order to achieve the main objectives of this theme, which is to be able to apply the obtained knowledge and experience for the development of new catalysts, new synthetic products, new metal recovery systems and new drugs, 5 secondary objectives have been detailed:

1. Biomimetic chemistry dealing with synthetic analogues of active metal centres present in metalloproteins and on DNA, including biomimetic production of H_2, N_2, O_2, using (photo)catalysis and also activation of O_2, N_2 and hydrocarbons by synthetic metal centres.
2. Development of new metal-containing diagnostics and drugs; including the detailed understanding of the mechanism, eventually leading to improved drugs.
3. Metal recovery from waste (water) using chemicals based on biological chelation principles (use of plants and bacteria in environmental cleaning).

4. Specific synthesis of organic compounds, using bioinorganic catalysts, with special attention to chirality.
5. Molecular recognition (metal ion-ligand interactions).

B. Selective synthesis.

Coordinator: Prof. L.Ghosez, Louvain, B.

The main objective for this proposal is the search for new selective synthetic methods and their application for the development of new synthetic products, fine chemicals and drugs. In order to achieve these goals, 6 sub-projects have been identified:

1. Asymmetric syntheses based on the use of efficient chiral auxilliaries, or chiral catalysts or on the transfer of chirality from natural or modified natural products.
2. Synthetic methods based on the use of heteroelements or organometallic compounds with a particular emphasis on homogeneous catalysis.
3. Biosystems as catalysts for reactions with a particular emphasis on the use of enzymes in organic solvents and the application of catalytic antibodies to organic synthesis.
4. Design and execution of efficient strategies for the preparation of complex molecules of value as potential drugs, agrochemicals, molecular materials,etc.. Particular attention should be given to the improvement of properties of biologically active natural products and the finding of new "lead compounds".
5. Organic synthesis at interfaces:heterogenous and phase transfer catalysis.
6. Application of biosynthetic pathways in total synthesis.

As can be seen from the themes above, a certain degree of overlap is obvious, and high priority should be given to projects combining different secondary objectives in order to reach the goal for the main objective.

C. Theory and modelling of chemical systems and prosesses.

Coordinator: Prof. A. Sgamellotti, Perugia, I.

The main objectives of this project can best be described by the 3 subproject identified:

1. Structure and Spectroscopy. TThis project will consentrate on investigation of the structure and properties of isolated molecules and solids as well as to the determination of intra- and inter-molecular potentials. To this end accurate traditional and innovative techniques have to be used.
2. Reactivity and molecular Dynamics. Investigation of reactivity and dynamics of molecular systems on ground and exited states also under also under the effect of pertubing fields. Gas-gas, gas-surface, and gas-solution processes will be investigated using accurate 3D and approximate theoretical approaches as well as advanced experimental techniques.
3. Simulation and modelling. Investigation of complex systems using statistical, graphical, mechanical, dynamical and kinetic means. The project will be particularly concerned with the modelling of liquids, solutions, drugs and other high complexity systems.

D. Design and preparation of new molecular systems with unconventional electrical, optical and magnetic properties.

Coordinator: Prof. J.A.McCleverty, Bristol, UK.

The main objectives of this proposal include the synthesis and characterization of polymers. Also supramolecular chemistry as it relates to preparation of substances with designed physical properties which may refer to aspects of molecular recognition, aggregation, formation of liquid crystals and other complex fluids, in the generation of stacking systems, molecular pillars, molecular wires etc. are of interest.

Subobjectives have been identified and are as follows:

1. The design, synthesis, structural and physical characterization of molecules which are capable of functioning as, or being converted into, molecular electronic devices. This will be achieved either by the development of new

systems which are capable of having appropriate properties built into them (e.g. incorporation of photo-centres, paramagnetic metal ions, charge-responsive centres etc.), or by modifying excisting molecules (synthetic or biological) by appropriate functionalisation.

2. The design, synthesis, structural and physical characterization of molecules which exhibit, when aggregated, a substantial degree of long range order, the synthesis of molecules which are the basis of complex fluids, e.g. thermotropic liquid crystals and amphililic systems.
3. The design, synthesis, structural and physical characterization of molecules which, in bulk, exhibit useful and/or extraordinary physical properties, e.g. optical, magnetic or electrical.
4. Physical limitation on information processing in molecular systems, e.g. by quantum-fluctuations.
5. To relate the science developed by fulfilment of the above mentioned objectives to the bulk properties of materials.

In order to fulfil the main objectives of the proposal, subprojects including molecular electronics, molecular conductivity, molecular magnetism and molecular opto-electronics are proposed.

E. Chemistry at surfaces and interfaces.

Coordinator: Prof. S.Pejovnik, Ljubljana, Yu.

The basic objective of this proposal is that it should be a contribution to the understanding of fundamental aspects governing surface chemistry. Specifically, the aims are to develop novel methods for the fundamental analysis and corresponding theoretical description, design, preparation and subsequent analysis of surfaces and interfaces at the microscopic level.
4 sub-projects has been identified, which will form the basis for reaching the main objectives of the proposal.

1. Analysis of theory of surfaces, which will include "in situ" examination of surfaces and development of new analytical methods of relevance to the whole field. Theoretical methods for description of chemical processes at interfaces will be an important part for molecular modelling of species at

surfaces and interfaces, quantum mechanical treatment of the chemical bonds at interfaces, simulation of structural analysis and description of non-linear dynamics of open systems under non-equilibrium conditions and their temporal behavior on external parameters.

2. Heterogeneos catalysis will include dynamics of chemisorption of individual molecules, their interaction and final product desorption as well as relaxation of the catalyst surfaces to its initial state. Studies relating to surfaces, sorption and surface reactivity in order to explore the possibility of a "first principle" design of a surface able of achieving a desired catalytic reaction at high turn over, high selectivity and insensitivity to catalyst poisons are also of importance. "Contaminated" surfaces of practical importance defy proper understanding, and therefore "in situ" studies are of great importance. Essential are also the physico-chemical as well as geometric characteristics of the surface at an atomic level and the local electronic structure that is associated with it. The nature of intermediate phases of product preparations is also of importance.
3. Molecular surfaces. Important topics in this area are preparation, characterisation and technological application of molecular surfaces, interaction between solid surfaces and solutions, modification and restructuring of surfaces by chemical reactions induced by the scanning tunnel microscope. Determination of the role of chemical interactions and the adhesion between polymers and metals, polymerization processes at solid surfaces, elemental photochemical and thermal steps in metalorganic chemical vapor deposition prosesses including the detection of important structures and the rôle of surfactants on epitaxial growth are also important areas.
4. Chemistry of highly dispersed systems will include surface and colloid science relevant to several disiplines. Focus should be given on the characterization and modelling of chemical reactions at the interfaces of highly dispersed systems, their formation and the development of new high selective preparation techniques. Questions about the relevance of nanoparticles for application in highly dispersed solid systems should be answered.

F. Chemical prosesses and reactions under extreme or non-classical conditions. Coordinator: Prof. H.G.Wagner, Göttingen,D.

The main objective of this project can be summarized as the "Investigation of the chances offered by the application of process technologies under extreme or unusual conditions for highly reactive and selective methods in chemical transformation." It should aim at possible applications in the process integrated environmental protection and the synthesis of materials with unconventional properties.

Secondary objectives are:

1. Diagnostics and modelling of the process taking place under extreme and unusual conditions.
2. New highly selective and reactive routes in the synthesis of organic and inorganic compounds.
3. Synthesis of new materials with unusual electrical, magnetic, optical and mechanical properties.
4. Activation of inert substances.
5. Hazardous waste treatment.
6. Scale up of laboratory reactors for practical applications.

The fields mentioned above may have a close realtionship to other of the proposed projects, and priority should therefore be given those which combine or compare different extreme or unusual conditions.

G. Molecular recognition chemistry.

Coordinator: Prof. M.Martin-Lomas, Madrid, E.

The main objective for this project is "To understand the non-covalent interactions which underlie molecular recognition phenomena in both biological and non-biological systems, to study the structure of these supramolecular systems and to develop practical applications from this fundamental knowledge."

The following secondary objectives have been identified in order to reach this goal:

1. Analyse, at the molecular level, the structural features applied by nature in molecular recognition phenomena with particular emphasis on DNA-protein, protein-protein and carbohydrate-protein interactions, as well as the nature of drug (either natural or unnatural)-receptor interactions.These studies include the characterization of interacting molecular systems and their role in the biological processes as well as the development of chemical approaches to the understanding of the structure-function relationship which underlie recognition events.
2. Development of strategies for control of enzyme activity with emphasis on selective chemical modification of active site or secondary structure.
3. Strategies for preparation of specific catalytic antibodies and their application in the achievement of selective reactions. Special attention should be given to the use of specific catalytic antibodies for the hydrolysis of proteins and peptides at specific sequences.
4. The study of self-organization of molecules and development of co-aggregates such as bilayers, catalytic micelles, liposomes and vesicles (to be used as stereoselective catalysts and for chiral recognition) or biomimetic ionchannel structures, and surfactants to be used for biomimetic ion transport, drug delivery systems, and models for prebiotic selforganization and self-replicating molecular systems.
5. Design and synthesis of new polymeric materials as models for reactive biological systems, membranes and biomembranes, as solid phase catalysts for asymmetric synthesis, as chiral stationary phases and as reactive microgels.
6. Host-guest chemistry with emphasis in inclusion compounds, including molecular engineering of crystals. This should shed light on the nature of intermolecular interactions and on their influence on the geometry of molecules and crystals.
7. Develop efficient preparation and characterization of uniform heterogeneous catalysts as zeolites, lays and pillared clays, as well as their application in the achievment of selective chemical transformation.

8. Design and synthesis of artificial receptors based on molecular recognition of selective transport and catalysis, for model studies of specific interactions in biological systems and for the development of new molecular devices with unconventional properties.

The Ad Hoc Technical Committee in Chemistry (COST-comittee in Chemistry) has proposed seven projects for COST action. They have all been described above. The committee has also identified certain areas within each project which may have relevance for other proposed projects. All projects contain elements of multidisiplinarity , and it is the opinion of the group that the basic knowledge obtained through the various projects proposed are important for the future development of many types of industry in Europe in the future.

Summary report COST Forum Chemistry; November 22, 1991; Vienna, Austria

Prof. Dr. J. REEDIJK, Leiden University, The Netherlands

The session was attended by about 40 persons, most of whom were present all afternoon. Apart from representatives of the 15 already involved COST countries, representatives were taking part from Austria, Hungary, Poland and Czechoslovakia. The newly present countries took part actively in the discussions.

Generally, it was highly appreciated that Chemistry is now present as an area under its own name within COST. The 7 topics selected and detailed by the ad-hoc committee were very well received by the member countries, including the new members from central Europe. These countries announced that they almost certainly will take part in several (if not all) of the 7 topics.

The 7 COST Chemistry topics are:

1. Coordination Chemistry in the context of Biological and Environmental Studies
2. Selective Synthesis
3. Theory and Modelling of Chemical Systems and Processes
4. Design and Preparations of new Molecular Systems with Unconventional Electrical, Optical and Magnetic Properties
5. Chemistry at Surfaces and Interfaces
6. Chemical Processes and Reactions under extreme and non-classic Conditions
7. Molecular Recognition Chemistry.

Special attention was given by the AHC to an arrangement of sub-topics that would:

a) increase the international collaboration possibilities,

b) encourage and increase industry-academia joint projects.

The topics were also based on 4 main areas from the ECCC report **"Chemical Science and Technology: European needs for the 1990s"**. (Prepared for the Commission of the European Communities under the responsibility of the European Communities Chemistry Committee, 1990). These topics are:

* Advanced materials, renewables and environmentally friendly substances
* A better environment: safety, hygiene and pollution control
* Efficient communication and transport
* Food and health in the 21th century

The 7 chemistry topics were generally accepted to describe a significant fraction of most active chemistry in Europe. The interdisciplinary aspects of the 7 projects and their mutual crosslinks were highly appreciated.

It will be proposed that a Technical Committee of Chemistry will be installed by COST after the mandate of the AHC expires (spring 1992). The committee could then - in due time - explore the start of new actions.

It was generally agreed that localisation of interested chemists inside the COST countries has been rather easy on the national level. For coordination at the international level, the AHC has been extremely helpful.

The forum concluded that good interactions with other European organisations, like ESF (for Euroconferences) en DGXII (for networks within the "Human Mobility and Capital" programme) are possible and should be encouraged.

A small working party of the AHC is setting up guidelines for the concertation, to assure that each of the 7 topics will develop along similar lines (this is specially required because of the many crosslinks and mutual overlap).

Problems were signaled on the following items:

1. The national funds to allow scientists to take part in COST not at all have to be clear and available in omparable amounts. It is also feared that in a few cases funds for regular funding will be used co finance the concertation, rather than specially generated funds as required by COST.
2. It is also feared that certain countries, especially from central Europe, do not have funds at all, to allow their scientists to take part in the concertation. It would be useful whether the EC, e.g. through a special Tempus project, could support these participations.

Finally, thanks were expressed to COST and its secretariat for having started and stimulated the development of the Chemistry programme.

E. SOCIAL SCIENCES

Workshop "Social Sciences"

COST - SOCIAL SCIENCES. AN OVERVIEW

by Bo Öhngren

Introduction

It was indeed good news hearing in 1989 that the Committee of Senior Officials (COST) had discovered the scientific potentials of the social sciences. The creation of the Ad Hoc Committee for the Social Sciences implied that social science had a role to play on the European research arena. I am also totally convinced that researchers in the field are ready to give important contributions to the otherwise predominantly technological programmes of COST as well as the Community scientific programmes at large.

The time is also ripe for a more integrated multidisciplinary cooperation between social science and technology. In many important areas the appropriate technology is at hand, but how to implement it, how to change human behaviour, how to create feasible institutions, how to obtain the optimal organizations in order to benefit of technological progress? - The list of areas where social science may play a crucial role could have been made much more extensive, but my task here is to give a short introduction of the COST activities in the social sciences. I also think that the next speaker, professor Helga Novotny, chairperson of the ESF Standing Committee for the social sciences, is more apt to act as an advocate for the social sciences.

Anyhow, before dealing with the COST programme proper, I would like to dwell on some more general remarks concerning social science in the new European context.

It would benefit the research community as well as the society at large if the social scientists could be more confident, assertive and leave, the more or less, defensive image which has been predominant so far. Social science is not just a problem solver, producing relevant information for policy makers it also has a critical role to play, to question phenomena in the society. On this qestion I think it is appropriate to quote a dear friend and a prominant scholar from Finland, professor Erik Allardt. Under the title of "The Janus-headed Nature of Social Science", in the October issue of ESF, Communication, he writes:

"Yet, if social sciences are accepted as legitimate partners of other sciences it has to be realised and accepted that social science by its very nature is Janus-headed. It produces information which can be useful for promoting existing structures and social practices but it may also produce knowledge which is revolutionary not only in its theoretical content but also in its social and political implications."

Reflecting on the current political and social development in the broader European context it is evident that social science has a great potential but a the same time a great responsibility.

Mandate

At their meeting in Dublin 1989, the COST Senior Officials decided to set up an ad hoc social sciences committee and charged it with the following mandate:

- to explore social science projects of an applied nature which relate to specific S/T research, which are relevant to a broader European context for the COST cooperation, and which give scientific and added value resulting from international cooperation.

- to submit concrete proposals for cooperation, (indicating COST cooperation requirements) and avoid overlapping activities in other fields.

Procedures, Criteria and Selection of Topics

Following the first meeting of the Committee in October 1989, all countries were asked by letter for national proposals in accordance with the propositions given in the mandate. Also, proposals from the Senior Officials' Meeting held in Dublin in 1989 was taken into account. Out of the 30 proposals submitted, a limited number of topics were selected for further elaboration.

The following set of criteria was agreed upon for the selection of topics, and as a guideline for the subsequent work:

- added value resulting from international collaboration

- scientific value

- prime focus should be on social sciences and S/T, and of applied relevance.

- European relevant aspects

- synergetic effects of confronting S/T and social sciences

- avoid duplicating work with other European organisations.

The Committee has, on several occasions, put emphasis on the need for comparative research and inter/multi-disciplinary research. Consequenty, the Committee, with its broad international and disciplinary composition, has identified areas where more comparative and multi-disciplinary research is needed, a concerted action of which the European States would greatly benefit from.

In its first working phase, the Committee has identified broad research fields as being in great need for further exploration: unification of Europe - New Technology - Employment - Demography (Ageing and Migration) - Social Systems and Social Structures. Cutting across all those areas, the very import and crucial factor was the "cultural diversity in Europe". The Committee felt that the problems concerned with the vast array of cultural, social and normative attitudes towards technological implementations will be of utmost importance. The unification of Europe in economic and political terms will not substantially weaken the cultural heterogenity of Europe for a long time to come. It has been emphasised that cultural factors are working on basic levels. Therefore, the cultural dimension will also permeate such technological oriented projects as "Management and New Technology".

The 30 themes proposed had sometimes been overlapping to a certain extent. The Committee therefore tried to focus and identify areas which might be of common interest and which are inherent in the criteria chosen.

Themes which were originally considered, such as "social values", or the proposal on "Science and technology policy and European integration" was rejected because it was not considered researchable, and very few countries showed any interest at all in the topic.

The theme "Common European Home and Eastern European Restructuring" was finally dropped, despite the high degree of interest, because the COST criteria meant that it would not be properly tackled due to lack of access to Eastern European countries or institutes.

The Committee rejected the idea of launching an environmental project for several reasons, in spite of the great interest shown by many countries. The problem is that there are so many on-going programmes in that area that there are no top level scholars left to work on it. However, the environmental issue will not be totally abandoned; environmental technology will play an important role in the project on the "Impact of the Social Environment upon the Creation and Diffusion of Technologies", and environmental circumstances (problems) will probably have an essential role when dealing with "migration" between Eastern and Western Europe.

Some of the areas put forward by the Senior Officials are not explicitly mentioned in the Committee's proposals but to a certain extent they are embedded. "Telecommunication" might serve as an example. It is very relevant for topics such as "Ageing and New Technology", "Management and New Technology" and also for "Migration". "Ageing and New Technology" will draw on results from COST 219 and 220 which are dealing with telecommunications and disabled persons. Therefore, an information link will be assured.

All the proposed projects have, beside the scientific value, a great potential policy element and can therefore claim to be of an applied nature, besides the established scientific values.

When selecting topics, the Committee has tried to avoid overlapping with other European programmes, and in cases where overlap exists in a broader sense, the Committee has narrowed the topic down and given it an original focus or has made the projects complementary. For example, the "demographic" theme has been focused on "Ageing and Technology" and finally special attention was put to the Third Age and the working life with the aim to explore possibilities for dependence and an active life at this time.

To avoid overlap, particularly with the European Science Foundation, the Chairman have explored the situation of research projects and participated in ESF meetings. The Vienna Centre has also been observed. With the C.E.C., the secretary has explored the situation of ongoing activities. In particular, the environment topic has been abandoned because the Commission is preparing a larger programme with a sub-aspect on socio-economic research.

To sum up, the projects proposed have been identified as projects of great scholarly interest. They have a multidisciplinary and comparative approach; they are also of an applied nature, and they focus on Europe as such, but are taking into consideration the vast cultural and social heterogenity that still exist in Europe.

With regard to research organization it is very important to state that the projects proposed are initiated bottom-up, i.e. the ideas are coming from the work-shop floor, from the researchers. What the committee has done is to delineate the "playground". Now it is up to the researchers themselves to identify and specify the most relevant topics within this broader context.

In order to facilitate the working procedures the Committee has commissioned certain member states to organize seminars on the proposed four projects. The last one, on Migration, was held in October in Belgium. That means that even before the actual signing of each "Memo of understanding" scholars ative in the relevant research areas have been able to establish working relations and put the research agenda under scrutiny. Unfortunately it has not been possible to invite participants from the new member countries to those activities. However, after this meeting in Vienna we do hope that they very soon will be integrated in the COST framwork.

The projects launched so far are :

1. Migration - Europe's Integration and the Labour Force (A2)

2. Management and New Technology (A3)

3. The Impact of the Social Environment upon the Creation and Diffusion of Technologies (A4)

4. Ageing and Technology. Third age and attitudes to working life (A5)

The Committee has also approved of two new projects; "Evaluation of action against drug abuse in Europe". Already in its preliminary state this project has aroused great interest among several member states and will probably get started early next year.

The second project is focused on "The Evolution of Rules for a Single European Market" and is planned to start Spring 1992.

During the last six month great efforts has been devoted to the problem of " East-West Migration/Brain Drain" in order to assess the potential for such a research topic within the framework of the social science programme. Dr Barbara Rhode has been responsible for arranging a seminar and draftning a report to the COST Senior Officials. The report gives an overview of the situation and proposes a possible outline for a COST-project on this relevant topic. The Committe would very much like to take the opportunity during the COST FORUM to discuss this topic with the new member states.

Although the COST Social Sciences has not produced very much until now we have already enough experience to state that European networks are needed concerning the above mention problem areas.We can also see that the different projects have some common denominators. What the Committee is launching is not just a set of independent projects rather a programme for European social science.

However, to be realistic, in order to obtain maximum success there is a need for additional funding concerning planning-coordination and monitoring the projects. There should also be funds available for work-shops and seminars. Having this the Cost framework could give European Social Science a push forward. The programme is not competing with other programmes rather being a very important complement.

SOCIAL SCIENCES
IN THE CONTEXT OF
THE EUROPEAN COMMUNITIES

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October 1991

SOCIAL SCIENCES IN THE CONTEXT OF THE EUROPEAN COMMUNITIES

CONTENTS

SOCIAL SCIENCES IN THE CONTEXT OF THE EUROPEAN COMMUNITIES

EXECUTIVE SUMMARY

1. Social Science provides explanations for and understanding of individual and collective human action. The social sciences thus comprise a wide range of disciplines, including: economics, environmental studies, political science, geography, psychology, sociology, management and business studies, social anthropology, education and socio-legal studies.

2. In this report, as a consequence of the terms of reference given to the authors by the European Commission, emphasis has been placed on the value of social science research in relation to the management of technological change and science policy. It needs to be stated clearly at the outset, therefore, that this report gives only a glimpse of the potential importance of social science research across a wider range of Community policy areas. The traditional core of the social sciences is concerned essentially with the systematic analysis of social, economic and political change. In the present times of dramatic change in both Eastern and Western Europe, policy-making would benefit from harnessing (and strengthening) social science research that addresses the dynamics of change in European countries and regions.

3. Social science in Europe is generally of high quality but characterised by uneven development. There are areas of world class excellence, but the building of a well-organised social science community at the European level is at its early stages. The availability and use of the most advanced quantitative and qualitative techniques needs to be better structured to maximise both expertise and resources. In some countries social science communities are sizeable, but new entrants have been relatively few in recent years; elsewhere, social science communities are smaller and younger; both need to be strengthened.

4. European social science contributes to the enhanced competitiveness of European industry by providing the basis for:

   - better decision-making at European level
   - more effective democracy in Europe
   - better understanding of issues fundamental to the long-term future of the Communities

5. There is a specific need for more comparative work on the sources of industrial competitiveness between Europe and, especially, Japan and the U.S.A. Existing research effort is currently dispersed, fragmented and lacks the necessary institutional infrastructure. The situation with regard to technology assessment is particularly urgent. The Commission needs to promote more integrated, multi-disciplinary studies of technological innovation which span the social sciences and the natural and engineering sciences.

6. It can be readily demonstrated that both within current Community mandates (agriculture, regional development) and prospective mandates currently under discussion (health, transport infrastructure) the Community is not yet in a position to obtain the potential benefits from European social science.

7. The reasons for this can be traced to five *barriers* to an effective mobilisation of European social science:

   (i) the still predominant orientation of social science research to the nation state (including an outdated application of 'subsidiarity')

   (ii) the current gap between the quality of most national data and what is available on a European level

   (iii) the weakness of links between research institutions

   iv) the need to develop and improve human resources

   (v) correction of the false image of the social sciences

8. We therefore propose a way forward which will allow the effective mobilisation of European social science, while tackling these barriers:

   (a) enhancement of social science input directly into decision making;

   (b) some provision for:

      (i) social science inputs into all Community research programmes;

      and

      (ii) a modest, but designated, social science research programme;

   (c) enhanced provision for European social science data resources;

   (d) provision for development of European human capital in the social sciences - through fellowships, networks and conferences;

   (e) development of existing - rather than creation of new - European institutions involved in the European social sciences.

9. Taken together, these initiatives would provide for the re-launching of European social science to a level of excellence which would provide substantial benefits for Community decision-making, European competitiveness and European democracy. We believe the opportunity is there and that the social science research community is ready to respond to the challenge. Practical, cost-effective steps can be taken which will enable Europe to regain its former pre-eminence in an endeavour central to its cultural history and future destiny.

SECTION 3 THE ROLE OF SOCIAL SCIENCE IN RELATION TO SCIENCE AND TECHNOLOGY IN JAPAN AND THE UNITED STATES, AND COMPARISONS TO THE COMMUNITY CONTEXT

3.1 Social science can contribute to the management of technical change in the following ways:

i) it can elucidate the factors which shape the emergence of new technologies and technological innovations;

ii) it can inform and help to define policy options, as well as evaluate the outcomes of a chosen policy or policies;

iii) it can assess the intended and unintended consequences, outcomes and feedbacks of technological change.

3.2 The social sciences have addressed these issues for some time. The role of firms, governments, human resources and other variables in relation to economic growth, industrial competitiveness and technical change strategies have been in the forefront of empirical research. In general, research has proceeded via detailed case studies and by building up aggregate technology indicators. The case studies have provided a number of important empirical insights, but these research efforts have not always been matched by the integration of results, a systematic comparative approach nor a cumulative growth of theory. It is here, we believe, that the Commission would have a distinctive role to play. Before outlining this, however, we will attempt to summarise the existing state of knowledge using the three categories outlined above.

3.3 Factors Shaping Technological Innovation

3.3.1 There remains a wide-spread belief that basic science, technological change and industrial competitiveness are linked in a direct and linear fashion. Social science research has demonstrated that this model is not only outdated but dangerously misleading. It is more accurate to state that the relationship between basic science, technological change and industrial competitiveness is interactive in each case. Thus, technology is not always predicated upon basic science: indeed, science is greatly enhanced and accelerated by changes in technology (and instrumentation). Similarly, the rate and direction of technological innovation is to a very large extent determined by the conditions of the market place and the skills and knowledge embedded within the economy. Just as technological innovation promotes a competitive economy, so human resources are crucial in determining the speed of 'technology transfer' and technological interchange.

3.3.2 The 'interactive model' has begun to influence the way in which economists understand the relationship between technological innovation and industrial competitiveness. In the past, many economists considered technical change to be an important, but exogenous, factor in economic growth. Now, however, technological change has moved to the centre stage in many economic analyses. Competition is seen as being driven by technological variety which is, in turn, continually evaluated - and therefore shaped - by the prevailing market environment. An example might be the 'enterprise culture' which appears as an active and variable element, both shaping and being shaped by technological change. This means that technology policy cannot and should not be limited to the 'economic implementation' of technological change. Rather, technological change is itself shaped by the wider context of, for example, social values, legislative and fiscal regulation and, crucially, prevailing market circumstances.

3.3.3 This complex interaction has been summarised in the concept of 'technological trajectories'. This attempts to identify the stages of growth which characterise patterns of innovation and diffusion. There is an early phase of 'vulnerability', where competition is fierce and random factors exert great influence in determining the directions of further growth and diffusion. Then, once sufficient momentum has been gained, a pathway or 'trajectory' becomes stabilised. Such a trajectory is capable of exerting more and more influence in drawing in related sectors, leading to increasing pressures for standardisation, and helping to shape markets. Via such a trajectory technological innovation is steered between the unpredictable and irregular patterns exerted by scientific innovation and the regularities exerted by the strategic behaviour of firms, governments and markets.

3.3.4 Thus, the notion of 'technological trajectories' underlines the importance of taking account of context. Japan, for instance, 'caught up' with the USA during a specific period of its industrialisation by taking advantage of the opportunities afforded to late-comers (as opposed to early adopters) within a particular technological trajectory.

3.3.5 These points have been exemplified in a number of case studies which have sought to compare Japan, the USA and Europe in terms of technological innovation and industrial competitiveness. For example:

i) the recent MIT study ('Made in America', Dertouzos et al, Cambridge, Mass., 1989) of industrial productivity in the USA and Japan emphasised the importance of organisational structures and social attitudes, which are independent of rates of investment, saving and capital costs. In order to understand the comparative industrial performance of Japan and the USA, the study isolated the managerial culture of the two countries, their respective educational systems, the nature of labour relations and the relationship between governments and firms as being the four key variables. It made clear also that the high rate of savings in Japan meant lower interest rates and higher levels of investment, particularly in long-term programmes.

ii) a recent study by Jean Claude Derian ('America's Struggle for Leadership in Technology', Cambridge, Mass., 1990) emphasised the contextual factors underpining technological change by contrasting those countries with 'exposed' cultures, dominated by competitive commercial activity, with those with 'sheltered' cultures, where the growth of hi-tech companies is ensured by the protection they enjoy through military and space procurements, public monopolies or a vast domestic market. Derian demonstrates that, whereas Japan is very competitive in the 'exposed' culture, the capabilities of Europe and its assets are concentrated in its 'sheltered' culture, where it has produced a number of highly successful technologies. Europe has, indeed, been one of the leaders in 'high fashion' hi-tech within a 'sheltered' culture; the USA, on the other hand, can still blend the talents of both the 'exposed' and the 'sheltered' culture.

iii) A study by Edquist and Jacobsson ('Flexible Automation', Oxford, 1988) has sought to determine the factors which lie behind the pattern and speed of technological diffusion, taking as an example certain types of automation in the engineering industries of Japan, Sweden, USA, the then West Germany and the UK. They demonstrate that the differences in the degree of diffusion are very large between these five countries. Robot density is, for example, 14.5 times greater in Japan than in the UK, and the density of flexible manufacturing systems is 9 times greater in Sweden than in West Germany. Indeed, the general degree of diffusion is much greater in Japan and Sweden than in the UK, the USA and West Germany. Sweden is, in other words, the only 'old' industrial nation to keep pace with Japan in relation to the diffusion of automation in the engineering industry. Among European countries, the UK and - surprisingly - West Germany are far behind the leaders.

3.3.6 These three studies suggest many issues for further enquiry - not least an in-depth comparative study of the way social science insights have affected competitive performance - and have very important implications for technology policy. Therefore, it is to the consideration of technology policy that we now turn.

3.4 Social Science and Technology Policy

3.4.1 Government intervention may be justified on the grounds of market failure. However, a recognition of market failure says nothing about how to intervene or whether intervention would be effective. An analysis of the causes of such market failure and the likely effect of intervention are important preconditions for the formulation and implementation of public policies. Such analyses may indicate which instruments to use if intervention is appropriate.

3.4.2 In the field of technology policy, for example, many nation states, as well as the Community itself, have set up priority areas in the form of programmes where basic and strategic science is funded with a view to accelerating technological applications and industrial competitiveness. However, studies like those referred to in the previous section have pointed out that economic growth may be accomplished and sustained without it being necessary to become a 'science leader' - although this is not to under-value the importance of scientific achievement. The significance of organisational structures and social attitudes, of saving rates and the cost of capital, and, above all, the behaviour of businesses at the enterprise level are at least as important, if not more important, to overall performance than the excellence of the science base and achievement of scientific breakthroughs. What also emerges is the vital importance of essential 'down-stream' project functions, such as design and verification, quality control evaluation and continuous efforts to improve product quality. Many obstacles to innovation have been identified at the level of the enterprise, again emphasising how much successful technological change depends upon factors outside the science and technology policy context considered in the traditional narrow sense. Most social science studies of science and technology policy therefore focus directly on issues relating to the enhancement of competitiveness. To a large extent they have highlighted the strategic technological choices open to the major players - firms, governments, inter-governmental institutions - and the empirical outcomes of choices taken.

3.4.3 Increasing attention is being paid to the interaction between human and technological resources. Technology is produced and used by humans. In the sphere of production this means that humans must possess skills in the appropriate mixture in order to be able to develop, produce, use and maintain technologies. With growing environmental concerns, technological innovation is also faced with the additional challenge of ensuring its contribution to long-term, sustainable growth. Paradoxically, the importance of human skills and education is increasing with capital intensity. The increasing complexity of production also raises the skill requirements for certain categories of employee. 'Multi-skilling' is becoming an increasing prerequisite in a number of high, and even medium, technology industries, demanding the integration of component fields, such as mechanical and electrical engineering. In addition, there is a growing awareness that the introduction of new technologies into the workplace has to be accompanied by other kinds of organisational change. In other words, technological innovation, cultural attitudes and social organisation have to be commensurate for economic competitiveness and efficiency to be sustained. This is epitomised in notions like 'technological culture' or 'enterprise culture'.

3.4.4 It is here, therefore, that policy interventions may be decisive. The social science literature on the role of science and technology in enhancing competitiveness makes it abundantly clear that technology policies are likely to be all the more successful if supportive measures are taken to enhance 'technical cultures' or 'enterprise cultures', which are based on a wide public level of acceptance. In Europe, for reasons which are linked to its history, culture and creativity, the future development of science and technology will crucially depend on public attitudes and public acceptance of innovation. It is a sign of the democratic maturity of European citizens that they have begun to demand increasing participation in the decision-making processes which guide the future direction of technology policy. The early involvement of social scientists in science and technology programmes could elucidate the importance of providing more opportunities for the participation of citizens, as well as contribute to the general expansion of scientific and technical culture.

3.5 Technology Assessment

3.5.1 Up to now, the field of technology assessment in Europe has proceeded on a rather narrow, cost-benefit basis, over-emphasising methodological issues at the expense of social learning. Indeed, much work in the field of technology assessment has been somewhat ad hoc in nature. Looked at across Europe as a whole, this field is only beginning to become institutionalised and to involve natural scientists, engineers and social scientists.

3.5.2 These weaknesses are in large part due to the ways in which the study of technology assessment is institutionalised. Some, but by no means the largest part, takes place in universities. Since most of the issues defy clear-cut division along disciplinary lines, many university-based scientific disciplines and departments are not prepared to undertake this kind of research. In the academic world, the field of science and technology-related studies is therefore only precariously institutionalised, since bringing together the social sciences and the natural sciences and engineering is still considered too radical to become more widely implemented. Therefore, much of the research work is carried out outside universities, sometimes in private research groups or by private consultancy firms. While this type of organisation has its legitimate place in social science research and enquiry, there are clear dangers where this research cannot draw upon the kind of long-term basic and strategic work which is usually undertaken in the university sector. Therefore, given the limitations of traditional university departments to conduct trans-disciplinary research, consideration will need to be given to new arrangements. Within the Commission, the MONITOR programme of strategic analysis, forecasting and evaluation has pioneered one line of approach. However, as the officials responsible would be the first to point out, MONITOR aims to identify new directions and priorities for Community research and technological development policy - it is not a basic and strategic research programme. Further steps are therefore required - for example, the deliberate commissioning of multi-disciplinary and inter-disciplinary research between social scientists, natural scientists and engineers.

3.5.3 The situation is urgent. As indicated above, the comparatively high educational standards of European citizens is leading to demands for better access for information bearing on the potential risks of new scientific and technological developments as well as environmental concerns. Currently a new kind of technology assessment is in demand, which is not only conducted by experts for policy-makers, but makes room for participatory procedures and the inclusion of interested and concerned citizens. These demands are unlikely to be of a temporary or passing nature. So far, science and technology policy-makers have often adopted a defensive stance or have attempted to ignore such demands. However, a new approach will be needed, addressing the wider political and cultural context into which the public acceptance and understanding of preferred policy options have to be placed. Compared with Japan and the USA, Europe has a unique opportunity to leap-frog current technology assessment and pioneer an approach which is anticipatory - accommodating social values and needs in the way technology policies are shaped and designed. This will also provide an exciting intellectual challenge; a truly interdisciplinary endeavour drawing upon the social and the natural sciences across Europe.

3.6 Conclusion

- Social science has contributed to understanding factors in industrial competitiveness, but a more systematic and sustained effort is needed.
- The social sciences have much to offer in relation to science and technology policy.
- The Community has a role to play in promoting and strengthening European social science contributions.
- If social science could be involved in science and technology programmes from an early stage, a more constructive public debate is likely to follow.
- The situation with regard to technology assessment is particularly urgent as well-functioning, European institutional mechanisms are needed to channel social science insights into decision-making procedures.

We return to these themes in Sections 5 and 6. However, before doing so, we wish to consider other important areas of Community policy where social science has an important role to play and where the awareness of social science appears to be somewhat lacking. The contribution of the social sciences goes well beyond science and technology policy issues.

Bo Öhngren
Chairman, COST Technical Comittee: Social Science
1991-12-20

Summary of the discussion in the COST-Forum workshop on Social Science, Vienna November 22, 1991.

1. The workshop on social science was very well attended during the whole session. Not a single chair was vacant and the dicussion was very vivid and proceeded without intermission to the end of session.

After personal introductions by the participants the chairman of COST:Social Sciences introduced and explained the proposed as well as the planned projects that will be launched by COST. The following discussion focused both on organizational and scientific matters. Especially participants from the new member countries got valuable informations on how to proceed and how to recruit researchers of high quality.

The participants from Hungary and Poland showed great interest in many of the proposed project and will quite evident join some of them as soon as possible. Unfortunately there was no delegate from Czecho-Slovakia, but from other sources the Technical Committee has got information that there is a great desire to participate in at least some of the proposed programmes.

The general discussion showed that there is a scientific need and wish in the new member countries for participating in the COST: social science programmes. It is now more a matter of instrumenting to get those countries in.

A topic that created a great deal of discussion was the topic " East-West Migration/Brain Drain". This topic raised questions of scientific as well as political and ideological concern. Everybody agreed, however, that this problem has to be dealt with in one way or other.

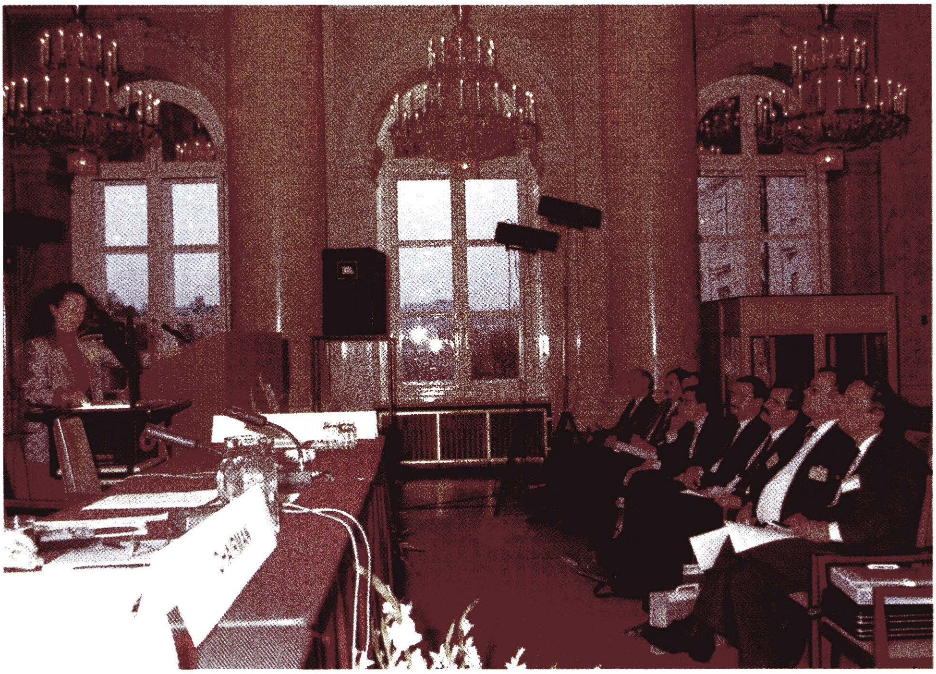
A crucial factor that was stressed was the importance of comparative research , especially with regards to cultural factors. That " the European house" does not consist of one family yet is quite evident and therefore it is important to focus on different levels of integration in Europe.

The ESF-ESRC- report presented by professor Helga Novotny was also on the carpet and there still are many unanswered question concerning the future of that excellent report. The general feeling , however, is that it should be diffused and dicussed widely in Europe in order to make political decision makers aware of the great potentials of the social sciences.

The workshop, and the COST-Forum too, turned out to be a very important occasion for information exchange from which all participants benefitted to a great extent.

As a concluding remark: the Forum is here to stay. In the future on different scales and approaches, but there is a need for more All-Eeuropean interdisciplinary meetings.

F. METEOROLOGY



Workshop "Meteorology"

THE IMPACT OF COST ACTIONS ON THE DEVELOPMENT OF METEOROLOGY IN EUROPE

by

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SUMMARY

Meteorology has provided study areas for a number of quite different COST projects over the last twenty years. The range and content of these projects is discussed and it is argued that the liaison and technology transfer which has occurred have been catalysts in Europe for rapid developments in some surface-based observational networks and in numerical weather forecasting.

1. INTRODUCTION

Operational meteorology depends upon a free and efficient exchange of observations of the atmosphere between countries. Indeed, without close international co-operation weather forecasts, even for quite small areas, cannot be contemplated. This was recognised towards the end of the last century, when the availability of telecommunication systems, and the increasing understanding that weather recognised no political boundaries, made international agreement on codes and protocols essential to the rapid acquisition of observational data. The establishment of the International Meteorological Organization (IMO) in 1873, which became the World Meteorological Organisation (WMO) in 1950, provided a focus for international collaboration and improvements in weather forecasting.

As aviation developed in the early part of this century so did meteorology. However, during and after the Second World War upper air observations using instrumentation carried aloft by balloon provided a basis for significant improvements in forecasting. At the same time the development of the electronic computer made numerical modelling of the atmosphere a practical possibility. During the twenty five years following 1945, the foundation of modern meteorology laid during the 1920's and 1930's, was developed rapidly. New observing techniques, such as radar, were developed, the first numerical forecast models were run operationally in the early 1960's, electronic systems provided rapid access to data and inexpensive powerful digital mini-computers emerged at the end of the 1960's. It is not surprising therefore that, when the COST Programme was initiated in 1970 (Roland, 1988), meteorology, one of seven areas within which European collaboration had been proposed in 1967, was included in the initial list of topics. Work on air pollution was included in an environmental topic, and will not be discussed in this paper, as in general work in this area has concentrated on the physico-chemical behaviour of pollutants in the atmosphere rather than on meteorological influences.

2. NUMERICAL WEATHER FORECASTING

As computer power and software operating systems developed during the 1960's, so did numerical weather forecasting. However, such work was concentrated in a very few centres worldwide. In Europe work in the UK and France demonstrated the enormous potential for improving operational weather forecasts, but also highlighted the need for a mechanism to be found for countries with limited resources for this type of work to benefit from these advances.

COST was the obvious forum within which to discuss how to proceed, and in 1970 COST-70 became the first project devoted to meteorology charged with considering co-operation in this field. Only three years later the work of the project was completed, and the convention establishing the European Centre for Medium Range Weather Forecasts was signed in May 1973 by seventeen countries. The convention entered into force on 1 October 1975. The COST mechanism had provided the synergy needed to bring into being an organisation which was to have a profound effect upon European meteorology as discussed by Bengtsson (1991).

3. METEOROLOGICAL OBSERVATIONAL NETWORK IN EUROPE

As the COST Programme began the operational observing network in Europe comprised a large number of manned observing stations and a much smaller number of upper air (radiosonde) stations. Some countries had also established networks of manually operated analogue radar systems. There were no operational digital radars before 1970 and there were no observations over the sea areas except those made from weather ships, merchant and defence shipping. The first weather satellite was launched by the USA in 1960, but the first geostationary satellite images received every half hour were not available for the European area until the end of 1977. It is not surprising therefore that COST meteorological projects following COST-70 should concentrate on improving the surface observational data base in Europe, particularly over the surrounding sea areas.

In 1978 COST-43 came into being to consider the practicality of, and, if appropriate, to develop, an experimental European network of ocean stations. After briefly considering automatic weather stations and radiosonde systems, COST-72 was specified to investigate the measurement of precipitation by radar. Both networks of ocean stations (buoys) and radars required technology which was just emerging at this time, and, as we shall see, the instigation of the COST Projects provided one stimulus for further development. It is interesting to consider whether these developments would have occurred had the COST Programme not been in place. We return to this point later.

3.1 Experimental European Network of Ocean Stations (COST-43) 1978-87

COST-73 was included in the topic area oceanography, but in fact addressed the problem of making meteorological measurements over ocean areas on the continental shelf. Axford (1988) provides a summary of the achievements of this project.

One of the initial aims was 'the common development of a complete network of automatic measuring stations allowing the collection and transmission of oceanographic and meteorological observations both along the coast and in the open sea' - a bold and far-seeing objective. However, it was rapidly realized that the technology was not at that time sufficiently developed, and that the most likely way of making progress was by a policy of short steps via **action concertee** by the interested parties. The Memorandum of Understanding (MOU) for COST-43 was developed with this in mind.

The project was implemented in two phases:

(a) Evaluation, testing and further development of existing and/or new systems (sensors, structures, transmission systems) provided in national programmes.

(b) Setting up of pilot networks in selected test sea areas, i.e. the Azores, Bay of Biscay, Faeroes/Shetland, North Sea/Baltic and Mediterranean.

The project was intended to form an opinion on whether an integrated European regional network would be feasible and politically practical, and was to take 4 years by **action concertee**. The initial signatories included Denmark, France, Ireland, Norway, Portugal, Finland, Sweden and the United Kingdom. (Other countries participated such as Belgium, Iceland, Italy. The Netherlands and Spain and signed later, and the Federal Republic of Germany was been a regular observer.)

Figure 1 (Pettifer, 1983) shows the areas and sites of common interest and the existing Ocean Data Acquisition Systems (ODAS) sites in early 1983. During 1984-88 the first Joint Venture Programme - System of Operational (drifting) Buoys in the Atlantic (SOBA) was planned and started operation. Six nations - France, Iceland, Ireland, The Netherlands, Norway and the United Kingdom participated.

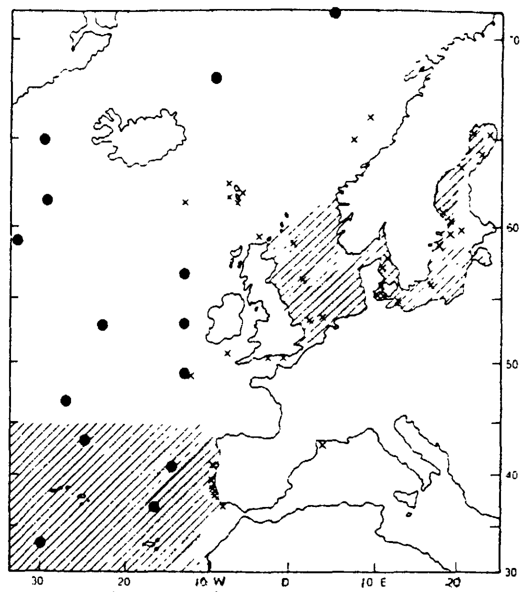


Figure 1. Areas (hatched) and sites of common interest for the establishment of new ODAS stations (solid circles) compared with those in place on 30 June 1983 (crosses) (from Pettifer 1983).

The basic elements of the SOBA programme are as follows:

(a) A minimum of two drifting buoys are kept operating in a specified area 55-63°N, 25-45°W at all times over a period of 3 years.

(b) The data are transmitted via the Argos system and received by local user terminals, from where they are disseminated in near real-time via the WMO Global Telecommunication System (GTS).

It was also during this period that COST-43 was able to send a representative to the Informal meeting on Observing Systems with particular emphasis on the North Atlantic which was held at ECMWF in October 1984. This led on to COST-43 participating in the Operational World Weather Watch Systems Evaluation for the North Atlantic (OWSE-NA).

The success of COST-43 can be judged by the fact that in 1979 there were very few established ODAS within the COST-43 area, apart from the highly expensive ocean weather ships. During the ensuing years over 60 ODAS stations have been established under the aegis of COST-43. Some have only been deployed for a short period, but many are maintained to be fully operational (see Fig. 2 COST-43 1986). Further, we now have two programmes in which drifting buoys are routinely seeded into chosen weather-sensitive areas of the North Atlantic.

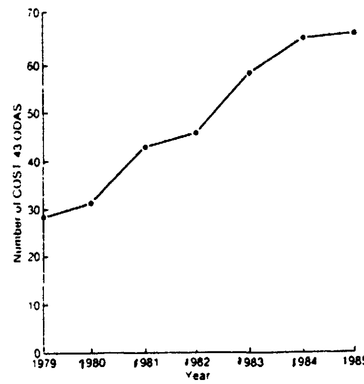


Figure 2. Operational COST-43 ODAS from 1979 to 1985 (from COST-43 1986).

3.2 International Weather Radar Networking (COST-72 and 73) 1980-85, 1986-91

COST 72 was concerned with the measurement of precipitation and the cost effectiveness of an integrated weather-radar network in western Europe. The Memorandum of Understanding of this project was signed by 13 countries: Austria, Denmark, Finland, France, Federal Republic of Germany, Italy, the Netherlands, Belgium, Spain, Portugal, Sweden, Switzerland, and the United Kingdom. Belgium, Spain, Ireland, Jersey, and Yugoslavia also participated in the meetings. COST-72 was a six-year project ending in December 1985 with the publication of a final report (EEC, 1985) and a final seminar held in Sicily, Italy (EEC, 1986). The project aims were a) to study the technical requirements and financial consequences of a co-ordinated approach to a European weather-radar network;b) to improve the quality of radar data, and the correlation between radar-data and meteorological phenomena, for short-period forecasting and other purposes; c) to optimize the cost-benefit ratios of national networks and, ultimately, European networks; d) to establish the feasibility of standardization of radar-observing systems to facilitate the economic production of equipment on a European basis; e) to establish the feasibility and usefulness of combining weather-radar data with cloud data from meteorological satellites.

Much of the work was carried out through a number of studies funded from within existing national programs. Effort was devoted to the study of the processing and use of single wavelength, single polarization, non-Doppler radar systems and data, as these radars were, or were about to become, operational in most western European countries. Nevertheless, the use of both Doppler and multi-parameter radars was studied also.

To obtain the full benefits to forecasting from using radar data, it is necessary to exchange data between neighbouring countries. However, it was not obvious to many European countries that wider data exchanges were useful, or achievable without considerable difficulty and expense. Hence, during the last three years of the COST-72 Project, the work of the coordinating committee was mainly directed towards the design, commissioning and assessment by questionnaire in an operational environment, of a pilot-scale multi-national weather-radar network, which would exchange data at low resolution in space and time. (Collier et al, 1988) Like the rest of the program, no budget from the European Commission for COST activities was available, and the pilot project was, therefore, funded, not without difficulty, from within existing national weather radar development programs. The coordination committee of COST-72 included in their recommendations a proposal for a new five-year project, subsequently known as COST-73, to be undertaken to study further the problems of weather-radar networking in western Europe. By October 1986 eight countries has signed a Memorandum of Understanding bringing the new project into being: Belgium, Federal Republic of Germany, Finland, France, Italy, the Netherlands, Switzerland, and the

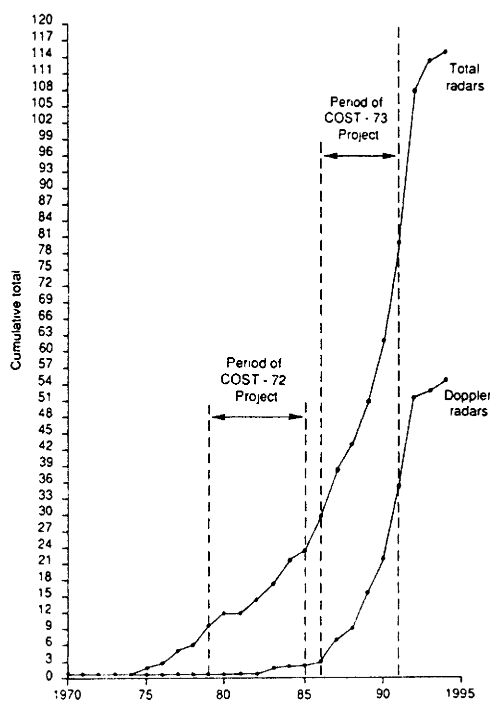
UK. They have since been joined by Portugal, Sweden, Austria, Spain, Ireland, Denmark and the Commission of the European Communities.

A number of off-line and real-time subprojects was studied including such off-line activities as studies of the usefulness of data from Doppler radars for forecasting purposes in Europe. However, what has been remarkable is the rapid deployment of digital weather radars in Western Europe during the COST-72 and 73 projects.

Western Europe outpaced the USA in establishing digital radar networks during the last twenty years. From a single operational digital radar (excluding research installations) in 1970, there are now over one hundred systems, half of which have a low power (much less than a megawatt) Doppler capability (Fig 3). The almost exponential increase in installations has accompanied the establishment of COST-72 and 73.

Figure 3

Growth of non-Doppler and Doppler radars with operational digital output in the COST countries of Western Europe



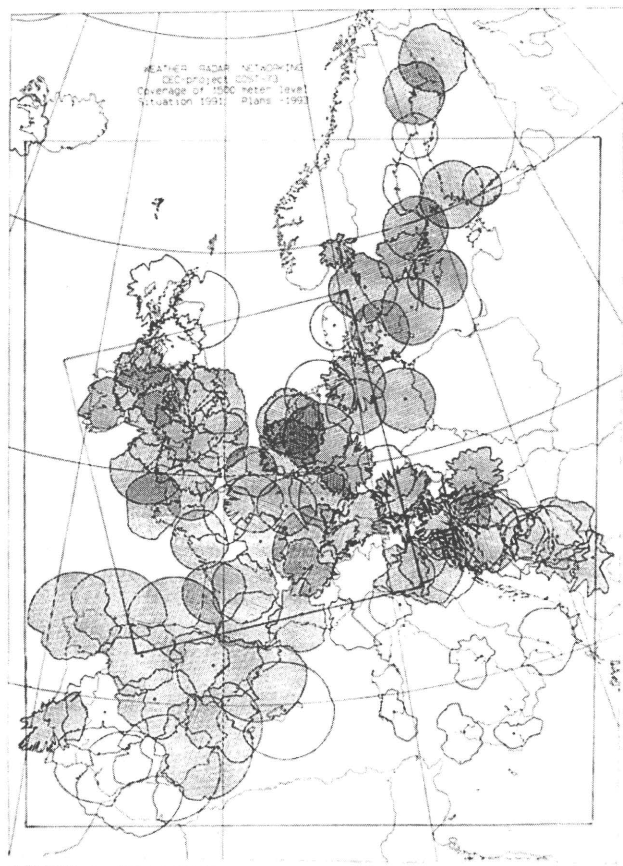
Developments in Europe are unlikely to mirror those in the USA, partly due to expenditure constraints, but also because the political make-up of Europe dictates that a European radar network embodying Eastern as well as Western European countries must be based upon existing national programmes if it is to be established successfully. In addition, the considerable investment in radar networks made so far by National Meteorological Services (NMS) will ensure that international radar data exchange will not compromise efforts to seek a financial return through commercial development. Consequently operational development will be carefully planned by the NMSs with the role of the CEC directed to the further encouragement of radar systems research.

As shown in Fig 3, over the last five years or so there has been a rapid increase in the number of digital weather radars deployed for operational weather forecasting purposes. Many countries are now operating radars as an integrated network (Figure 4) providing composite images to a range of users. There is a consensus throughout Europe and elsewhere that weather radar networks are an essential component to nowcasting and very short-range forecasting procedures.

The interpretation of radar reflectivity for estimating precipitation and severe weather has been reviewed within COST-73. Whilst certain algorithms are in common use, there remain differences in the way, and the degree to which, radar data are processed.

Although conventional radar networks will continue to be developed, Fig 3, compiled from COST-73 surveys, indicates that there is an increasing deployment of Doppler systems providing wind as well as reflectivity data. It is clear that one challenge in the future is to optimise the use of these systems within a conventional radar network framework. This will involve investigation of optimum antenna scan procedures as well as use of numerical weather prediction model assimilation techniques.

Figure 4



The COST-73 Final Report (CEC.1991) contains recommendations concerning the need for the maintenance of an inventory of installed weather radars in Europe and their coverage, begun during the Project. In addition,modifications to the FM BUFR-94 to enable such code to be used to transmit radar data have been made. These modifications have been incorporated into existing code procedures by the World Meteorological Organisation, and at least for the next few years, will underpin international radar data exchanged in Europe.

Current advanced radar techniques such as multi-parameter and Doppler systems were reviewed within COST-73. The potential of multi-parameter systems for distinguishing between precipitation types is clear, but on balance, it is likely that such systems will be deployed in Europe for special applications such as within hail identification projects and in weather modification and communications experiments. Nevertheless, it is probable that a few systems will be deployed operationally within more conventional radar networks. The need for studies of operational algorithms and scanning strategies is clear. Like the incorporation into network operations of Doppler radars, it is a major challenge to develop automated procedures for blending multi-parameter radar data with other types of radar data in near real-time.

Although more work is needed to develop further existing radar technology, COST-73 also studied technologies which have been developed, often in defence applications, but not yet for meteorology. These include electronically scanning and frequency agile radars. COST-73 has recommended that a new COST project should be established incorporating investigations of the following elements,

* electronically scanned (phased array) radars; design parameters, algorithms, availability limitations and potential.
* multi-parameter (including Doppler) radars; usage within current networks, algorithms.
* pulse compression techniques and frequency agility; performance optimization, design parameters.
* research into algorithms; combination of radar data types, derivation of meteorological parameters.

During 1991-92 countries from Eastern Europe will be admitted in the COST programme, and such a new project could provide a foundation for both development of the next generation of weather radars, and the impetus for the rapid deployment of existing radar technology throughout Eastern Europe. Of course funding will always be a problem. National Meteorological Services will be expected to underpin most of the radar activities, but the CEC should provide enabling capital for new radar technology and for applications of radar data.

3.3 Stratospheric-Tropospheric radars (COST-74) 1987-1993

On the completion of COST-72 it was recognised that Doppler radars at VHF or UHF frequencies might be able to provide vertical wind profiles of use in operational weather forecasting. The development of this technology, begun in the USA, has now advanced to the stage where systems are available commercially and a few have been deployed in Europe. Profilers can operate over a wide range of frequencies with a variety of characteristics as shown in Table I.

Table 1

Type of profiler	Stratospheric	Tropospheric	Lower Tropospheric	Boundary
Parameter				
Frequency	50 MHz	400 MHz	400 MHz	1000 MHz
Height Range	3 to 30 km	1 to 16 km	0.6 to 5 km	0.3 to 2km
Height Resolution	300 m	150 m	150 m	75 m
Antenna Area	1000 m^2	100 m^2	30 m^2	10 m^2
Peak Power	500 kW	40 kW	2 kW	1 kW

COST-74 involves participation by Austria, Belgium, Switzerland, Germany, Spain, France, Italy, The Netherlands, Portugal, Sweden, Finland and the UK. The Project is currently developing profiler specifications which will meet the various user requirements. Of particular concern are the radar parameters needed to cover the height ranges requested. The involvement of radar manufacturers is encouraged to ensure that the profiler specification is such that it can be manufactured economically. In addition, guidelines on the optimum spacing and characteristics of profiler networks for numerical weather prediction are being produced. Existing numerical models are set up to receive observations at fixed intervals of time (eg every 6 or 12 hours). The optimum use of nearly continuous profiler data in numerical models is being investigated.

Transmission and archival formats are being specified so that data can be effectively and efficiently transferred between instruments and users. To this end, proposals are being made within existing frameworks laid down by the World Meteorological Organisation. Problems have been encountered in obtaining frequency clearance to operate continuously around 50 and 400 MHz and future development of this technology remains somewhat uncertain. Nevertheless, it is likely that action under the aegis of COST will be of significant benefit if these radars are shown to be operationally beneficial.

3.4 Road Weather Conditions (COST-309) 1987-90

Arising from some of the recommendations made in COST-30 (set up in 1990) and 30 BIS (established in 1982) concerned with electronic traffic aids on major roads, COST-309 addressed the particular problems associated with the application of road meteorology to winter maintenance.

Controllable maintenance can be anticipated well in advance and is largely governed by traffic volume and regional budgets. This normally goes no further than preventative action and the repair of normal wear and tear. Due to the seasonal variation of the European climate however, there can be long periods when the weather has a profound but intermittent effect on road transport. The effects of inclement weather can to a certain extent be planned for in advance by careful interpretation of climatological data.

Even short delays can be significant however, and action must be swift and efficient in order to minimise disruption. There can be no doubt that prior knowledge of critical situations will produce a more effective and economic response to disruptive weather regimes.

As well as making obvious financial savings through more efficient winter maintenance, there are further benefits in the form of increased safety and less damage to the environment through the unnecessary application of chemical agents.

COST-309 addressed the various problems by allocating each of the eleven participating countries to lead a particular study project as follows:

* Sensors and Measuring Systems (Sweden)
* Overall Systems, Thermal Mapping, Data Transmission. (United Kingdom)
* Detection and Prediction of Fog (France)
* Weather Radar (Finland)
* Short Term Prediction, Prediction of Road Conditions (Sweden)
* Winter Index (Denmark)
* Weather and Accidents (Norway)
* Cost-Benefit Analyses of Road Weather Service (Finland)
* Communication between Meteorologists and Road Maintenance Authorities (The Netherlands)
* Dissemination of Information to Road Users. (Switzerland)
* Effects of De-icing Agents (Austria)

The collation of experience achieved by this project has provided a rich source of information and led to a number of recommendations. Of particular importance are the following:

* The testing and calibration of the road weather sensors and measuring systems, should in the future be a part of the normal activities of CIMO (Commission for Intruments and Methods of Observations) in the framework of WMO. However, the tests should be performed on road sections with the close co-operation of road authorities.

* Modern ice detection and prediciton systems should form the basis of an integrated winter maintenance strategy. Apart from accurate and reliable instrumentation, good forecast data are essential to the overall systems.

* Research is recommended into the establishment of a common protocol for the transmission data between forecast centres and local authority systems.

* A standard recording practice concerning road accidents and weather conditions/road surface conditions.

* Implementation of a European system for the exchange of road weather forecasts clearly calls for Europe-wide co-operation.

4. A CONFLICT OF AIMS AND ITS RESOLUTION

As the COST-43 project progressed several new ways in which nations can come together in joint projects in their common interest with the minimum of legal and bureacratic procedures were developed. The international liaison between COST and international bodies such as WMO ensured that the data generated under the auspices of COST-43 contributed to the wider requrement for data. As the project drew to a close, differences of opinion between nations became evident as to how to carry forward the work.

The COST Programme is an R & D programme, but inevitably the outcome of meteorological projects is the development or specification of pre-operational systems. Traditionally National Meteorological Services have regarded the specification of operational systems as their perogative. This is not surprising as such systems often involve the commitment of large manpower and financial resources. However, the aims of the earlier meteorological and oceanographic projects often included study of **modus operandi** for operational systems.

This difficulty was overcome in the case of COST-43 by international agreement to form a European Group on Ocean Stations (EGOS) within a WMO Drifting Buoy Co-operation Panel. In this way overall supervision of the ocean observing system was returned to National Meteorological Organisations through appropriate WMO mechanisms.

The same problem re-occurred at the end of COST-73. Although the Management Committee of this project adhered closely to their MOU, guidelines for the operational international exchange of radar data in real-time were developed. Some outside the Project felt that this extended the brief given to the Project. The response of the National Meteorological Services was twofold. A working group was established outside COST to consider further the operational use of European radar data taking account of the COST-73 work and, more significantly for future COST programmes, a COST Technical Committee for Meteorology was formed. Whilst the deliberations of COST-73 were not the only reason for the birth of this committee to oversee the whole area of meteorology, they were felt by some to illustrate the difficulties in taking further some of the recommendations of particularly successful projects with obvious operational potential. The Committee will in future review proposals for new COST projects in the meteorological field.

5. TECHNOLOGICAL TRANSFER AND THE STIMULATION OF R & D

There can be no doubt that COST programmes in the field of meteorology have led to significant developments in the observational system. Developments in individual countries have been promulgated throughout Europe, and this has stimulated others to recognise the potential of particular systems and contribute their expertise. European industry has certainly benefited from readily available access to requirements, and meteorologists have benefited in return from pragmatism displayed by industry.

However it is often individual efforts that have moved R & D along, and therefore the extent to which technological transfer has **actually** been achieved is not clear. It is easy to be deluded into thinking reality is something different! Nevertheless Figures 2 and

3 demonstrate amazing increases in the deployment of ocean stations and radars. COST-70, leading to the creation of a European Centre of excellence in numerical forecasting, is a prime example of making technology available to all countries in Western Europe. Also anyone reading the final report of COST-309 cannot fail to be impressed by the way in which national contributions are blended together.

COST-74 represents the latest project targeted at developing a technology for overall European good, and other similar projects are presently being considered by the Technical Committee. The incorporation of countries from Eastern Europe presents an exciting new challenge in transferring technology not previously available to these countries.

6. THE FUTURE INVOLVEMENT OF COST IN METEOROLOGY

The future is exciting. Previously new COST actions were proposed by individual organisations, or recommended by projects coming to an end. Draft MOU's were placed before the COST Senior Officials Committee. These mechanisms will continue, but proposals will now be considered first by the Technical Committee for Meteorology who will suggest further projects. This should ensure a balanced programme of complementary projects requiring the special R & D environment provided by the COST Programme.

Several new projects are being considered. These may move COST into some new areas of meteorology not directly associated with observing systems, which is the area largely concentrated upon since the completion of COST-70 in 1973.

Although the COST mechanism has administrative strength born through its informality and dependence upon existing national programmes, this does lead to a vulnerability. No central funding is available to support the national project work, although in some cases the CEC has placed contracts for a limited technical secretariat (COST-43) and project co-ordination (COST-73) effort. It is all too easy for National Met Services to decide to deploy their valuabale, and sometimes very limited, resources elsewhere rather than support new actions. COST has achieved so much over the last twenty years or so in the field of meteorology and the potential for major contributions in the future is clear. Hopefully action will be taken to limit any likelihood that nations will be discouraged from participation by purely resource limitations. COST has a major contribution to make to meteorology in the years to come. Every effort should be made to ensure that contribution is realised.

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DEVELOPMENT IN ATMOSPHERIC MODELLING AND WEATHER PREDICTION - THE ROLE AND CONTRIBUTION OF ECMWF

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1. BACKGROUND - THE FORECASTING PROBLEM

For scientists and laymen alike, the complex and variable motions of the atmosphere, and their manifestation in all kinds of weather, are a challenge to the human mind. We are all dependant on the weather in our daily lives, and for those exposed to the fury of Nature it can be a matter of life and death. Long-term variations in the weather, as is the drought in Africa, can be a threat to whole societies.

Prediction of the weather requires extensive observations of the present state of the atmosphere, and a thorough understanding of the forces that govern the atmosphere, including the complex interactions with the ocean and the land surfaces. Perfect knowledge of the weather is unattainable, for reasons which will be clarified in the following.

At first glance weather prediction is a well-defined, deterministic problem, like calculating the trajectory of a missile. Starting from a given initial state, any future state of the atmosphere can in principle be obtained from the classical equations of fluid dynamics developed in the 19th century. But a more thorough analysis soon reveals the enormous complexity which has the result that in practice, in spite of the theoretical determinism, we are dealing with a truly chaotic system.

Atmospheric processes span a very large range of scales, from the size of a cloud droplet (a few micrometers) to planet-wide scales of some 10.000 km. Within this great spectrum we find thunderstorms a few kilometers wide, frontal depressions in mid-latitudes stretching over thousands of kilometers and global scale circulations. Each scale of motion has its characteristic time scale: a thunderstorm lasts about an hour, and a frontal depression a few days, while the larger systems, such as the Indian monsoon, have time scales of months.

Intractable problems for the weather forecaster arise from continuous interactions between the different scales of atmospheric motions. In the tropics, for example, micro-scale fluxes of heat and moisture from the ocean and land create conditions that favour the generation of convective clouds. An individual cloud, about a kilometer wide, releases heat through the condensation of water vapour to water droplets. The heat creates winds which might set up a closed, local circulation around and beneath the cloud. In practice, many clouds occur simultaneously within a relatively narrow zone near the equator, almost encircling the earth, and they interact to create a large-scale circulation system - the trade winds. These winds bring to the tropics relatively cold and dry air from higher latitudes which efficiently absorbs heat and moisture from the surface of the oceans, in the micro-scale processes with which these large-scale circulation begins. Such interactions between the micro-scale and the macro-scale is typical for the atmosphere as are the interactions between the dynamics and the different physical processes in the atmosphere (see figure 1).

Because of these interactions between different scales of motion, small initial differences have large final effects. The beat of a bird wing might in theory alter the track of a depression. Although the prediction problem is in principle deterministic, it is in practice non-deterministic because of the inevitable errors in observing the smaller scales of motion. This will sooner or later contaminate the larger scales and finally destroy the accuracy of any prediction of the weather.

Even disregarding these conceptual difficulties, the sheer complexity of atmospheric processes meant that methods of weather forecasting were largely subjective, until the event of the computer. Since then progress in atmospheric modelling and forecasting has gone hand in hand with the ever-increasing speed of computers (figure 2).

Prediction of the atmosphere on time scales from a few days to a few weeks is regarded as perhaps the most difficult forecasting problem because we have to rely on an unusually accurate treatment of the atmospheric observations as well as on accurate modelling. Since weather systems can travel half way around the world in a week, the medium range forecast require global data (figure 3). To obtain global coverage through the whole depth of the atmosphere is a tremendous technical and economical task.

Observations from the surface are perhaps the easiest to acquire, and these provide, at 3 hr-intervals, values of pressure, temperature, wind and relative humidity. The best coverage is in the middle latitudes of the Northern Hemisphere, where a combination of fixed land stations and moving ships provides surface observations with a spacing of 200 to 300 km. Surface observations alone, however, are not sufficient for forecasting.

To define the three-dimensional structure of the atmosphere, a basic component of the observing system is the set of upper-air soundings by balloon-born sensors, flown at 00 and 12 UTC. These observations are obtained from about 700 stations in the Northern Hemisphere and 100 stations in the Southern Hemisphere. They rise through the atmosphere, telemetering values of temperature, pressure and humidity back to the ground. They are also tracked so as to determine wind velocity. Although the accuracy of the balloon-born sensors is satisfactory (about 1°C for temperature and 2-3 ms^{-1} for the wind), the value is limited due to unsatisfactory coverage. For economic reasons, the stations are concentrated in mid-latitude land areas where, in the Northern Hemisphere, they are spaced about 500 km apart. If the distance between the observations is greater than that, errors in interpolation become more serious than the instrumental error, in limiting the accuracy with which the state of the atmosphere can be determined.

More uniform coverage comes from satellite-based sensors that provide temperature soundings by measuring infra-red radiation at well defined wave lengths. They are sensitive to the temperature in different layers of the atmosphere which at present can be determined to within about 2-3°C. The poor accuracy, compared with that of balloon-born sensors, is compensated by a far greater number of data points and an almost global coverage.

The tracking of clouds, from satellites in geostationary orbits, provides information about winds. This is a most important source of data for tropical and sub-tropical latitudes, although some uncertainties remain about the reliability of clouds as tracers of air motion and the accuracy with which the satellites can determine their vertical location. Commercial aircrafts supply observations which are scarce, but can give wind data of higher accuracy by making use of the aircraft inertial navigation systems.

2. THE ECMWF

The European Centre for Medium Range Weather Forecast (ECMWF) was formally established on 1 November 1975, a date when its convention had received sufficient ratification to come into force. However, this followed a long period of careful planning and preparation which started as long ago as Octobre 1967, when the Council of Ministers of the European Communities adopted a resolution to promote a common programme for scientific and technical research. In 1970, the project was examined by representatives of western European countries and a new co-ordinating body called COST was set up to examine this project together with a number of other technical and scientific projects.

The problem of extending useful weather prediction into the medium range was singled out as one of several projects where a joint European effort was regarded as essential, and where, according to different assessments, the benefit would by far outweight the costs. Expressed in figures for the operational period 1980, at a 1970 price level, a cost-benefit-ratio of 7.6 million accounting units to 200 million accounting units was obtained, which is better than 1:25.

In the early 1970s there was enough experience in both short-range prediction and climate simulation by numerical models to justify the serious attempt to attack the medium-range forecast problem. In the planning documents leading up to the creation of the ECMWF, medium-range forecasting was considered to imply a period from 4-10 days ahead, but a more natural time-interval is perhaps 2 days to 2 weeks.

Medium-range forecasting was in many ways an ideal candidate for cooperation. The scientific and technical problems are formidable, and only very few countries have enough scientific and technical experts to tackle them. Moreover, the computer and other resources needed exceed those normally available at the national level. Medium-range forecasts are less time-critical than short-range ones, and it is therefore of little disadvantage from an operational point of view if they are made at a distance from the national meteorological services on condition that fast, reliable telecommunication links exist.

When ECMWF was created, preparations were in progress for a Global Weather Experiment, involving meteorological researchers of many countries. During that experiment, which was set to run all through 1979, several new observing techniques were to be tested on a quasi-operational basis. Two polar-orbiting satellites produced vertical temperature profiles of the atmosphere with a global coverage, while 5 geostationary satellites reported winds at two vertical levels over the whole tropical and sub-tropical belt. The satellite also collected data from aircrafts, drifting balloons and drifting buoys, and relayed them to the meteorological services all over the world. Computer development was in a very active phase, and the first machine that was really adequate for operational global weather prediction, the CRAY I-A supercomputer, was delivered to ECMWF in 1977 (see figure 2).

3. THE RESEARCH WORK

In spite of these encouraging circumstances, the research group at

ECMWF had to solve some very difficult problems. The first was to construct, from a variety of observations, all incomplete and with different degrees of accuracy, a complete global description of the prevailing weather, as the initial state for the computations. The data had to be extracted from coded messages amounting to some 10 million bytes of data a day. Automatic control systems had to be developed. A special statistical-dynamical method of analyzing global observations was developed. This was combinded with a prediction model to make a data assimilation system, in which observed data are checked against predicted data to determine their acceptability. The predicted values and the observations are then combined to give the most likely initial state of the atmosphere at the required time. Computationally, this task is almost as demanding and sophisticated as the forecast itself.

A particular problem arises when an observation that is not carefully inserted into the model generates spurious gravity waves instead of the meteorological features that the model sets out to predict. A special technique, developed at the Centre, eliminates these spurious modes without any harmful effect on the forecasts.

All computer models of the atmosphere rely on the hydrodynamical equations of fluid mechaniques, with certain approximations associated with the shallow depths of the atmosphere. Three-quarters of the mass of the atmosphere and most of its weather are contained in the lowest 10 km. The models also use equations for the transfer of heat and moisture, and the behavior of gases. In the ECMWF's global model, basic variables such as wind, temperature and moisture are presently specified at 31 levels, with a vertical spacing in the lower atmosphere of about 400 m. The world is divided horizontally by a series of wave-like functions with 213 waves in each direction, which create a grid spacing of about 60 km. It takes about 30 million numbers to represent the state of the atmosphere at a given time. The basic equations provide estimates for the rate of change for each variable, the value of which can thus be predicted for a time typically 20 minutes later. Then this process is repeated as often as is necessary to obtain the state of the atmosphere at some given time in the future.

Complications are many. The atmosphere is driven by differences in temperature, which are governed by the incoming radiation from the sun and the loss of heat from the atmosphere into space. Factors such as cloud cover, the water vapour of the atmosphere, and the absorbtion or reflection of sunlight from different parts of the earth and surface, strongly influence the extent of heating and cooling. Similarly, frictional processes at the surface, which provide the ultimate drag on the atmosphere's motion, have to be known in great detail, and this means that the topography and roughness of the terrain must be prescribed as accurately as possible.

The number and complexity of these and other factors to be included in the model have to be carefully judged, because they can easily put excessive demands even on the most powerful supercomputer. In the operational ECMWF model they increase a number of computations per time-step to about 35 billion, so that a 10-day forecast requires in the region of 25 thousand billion operations and takes more than 5 hours even on a CRAY Y/MP supercomputer using 8 processors simultaneously.

Observational and computational imitations make it necessary to confine a computer model to the description of phenomena larger than the grid-scale which is more than some 60 km. This is larger than any weather phenomenon, and so-called sub-grid processes must be related in a consistent way to the macro-scale. If, for example, the model generates moist convection, it must also produce a cloud, and the cloud must interact with the incoming radiation from the sun, and with the infra-red radiation from the earth surface and from the atmosphere itself. There is a notorious lack of quantitative observations or processes on the sub-grid scale, and further computer models to simulate them are becoming a major research tool.

4. OPERATIONAL ACTIVITIES

Over the more than 10 years of operational forecasting the centre's model has undergone significant improvements and useful forecast skill has been gradually increased.

The many improvements are due to better and more accurate techniques of describing the physical processes in the model and to better and more consistent use of the observations. The centre's medium-range forecasts are presently the best available in the world and are used worldwide.

The forecasts up to 10 day ahead, consisting of more than 50,000 fields of data, are transmitted each day from ECMWF to the 18 member states, via a dedicated telecommunication network (figure 4). The predictions do not go directly to the users, but to the meteorologists in the weather services of the member states who translate the global grid-points forecasts into local weather forecasts for the general public and for special paying customers. In addition, a subset of the forecasts is distributed worldwide to all countries of the world as quid pro quo for the data they provide to the European Centre and as a part of the overall international cooperation in meteorology.

The quality of the forecasts are assessed both by objective statistical scores and by systematic evaluation of their practical usefulness. Judged by any of these standard, the ECMWF forecast for day 3 is better than the forecast day 1 at the beginning of the 1970s and the forecast for day 6 is better than the forecast for day 3, 10-15 years ago.

One way of defining useful predictive skill is to require a correlation of better than 60 percent in the prediction of anomalies - that is to say, deviation from the normal climate for the time of the year. By this test, the forecast at ECMWF for the first winter extended the skill from 3.5 to 5.5 days, and to almost 8 days for the last winter in 1991 (figure 5). The skill is poor in the summer, but here too an improvement has been evident since 1979.

As confidence in the centre's forecast gradually increases, new applications and new users are being found all the time, especially as the selling of forecasts to special customers is becoming a substantial source of revenue for several European meteorological services. The increased usefulness is due not only to the improved skill in predicting the large-scale atmospheric flow. but to the prediction of parameters of direct interest to end-users. such as wind, temperature. cloudiness. and precipitation. Forecasts of such parameters are available daily for every part of the globe via the ECMWF data base. But they predict only the weather of the macro-scale. and have to be interpreted into local weather with due attention to small-scale features that are not resolved by the ECMWF.

Recent studies indicate that the limit of useful predictive skill can be extended to about 2 weeks, just by the elimination of errors within the model. Further extension will be possible if more observations can be obtained with higher accuracy. The reduction of the initial errors by half is expected to add another 2 days of useful predictive skill. Nevertheless, the predictability of the weather is not constant, but varies from time to time and from place to place. In certain episodes the atmospheric circulation is trapped into very stable regimes. for example when a persistent area of high pressure blocks the moments of mid-latitude depressions. and during such periods the growth of errors is limited and is generally confined to smaller scales. Other weather regimes are highly unstable and even the largest scales of motion are influenced by errors emanating from smaller scales.

ECMWF is so far the only COST project that has led to the establishment of a great common research institute. It has had the effect that meteorological research and operation has been concentrated on a centrally important area where Europe has taken a worldly leading role. It has improved the meteorological cooperation in Europe and become a focal point for meteorological research in Europe in a wider context.

FIGURES

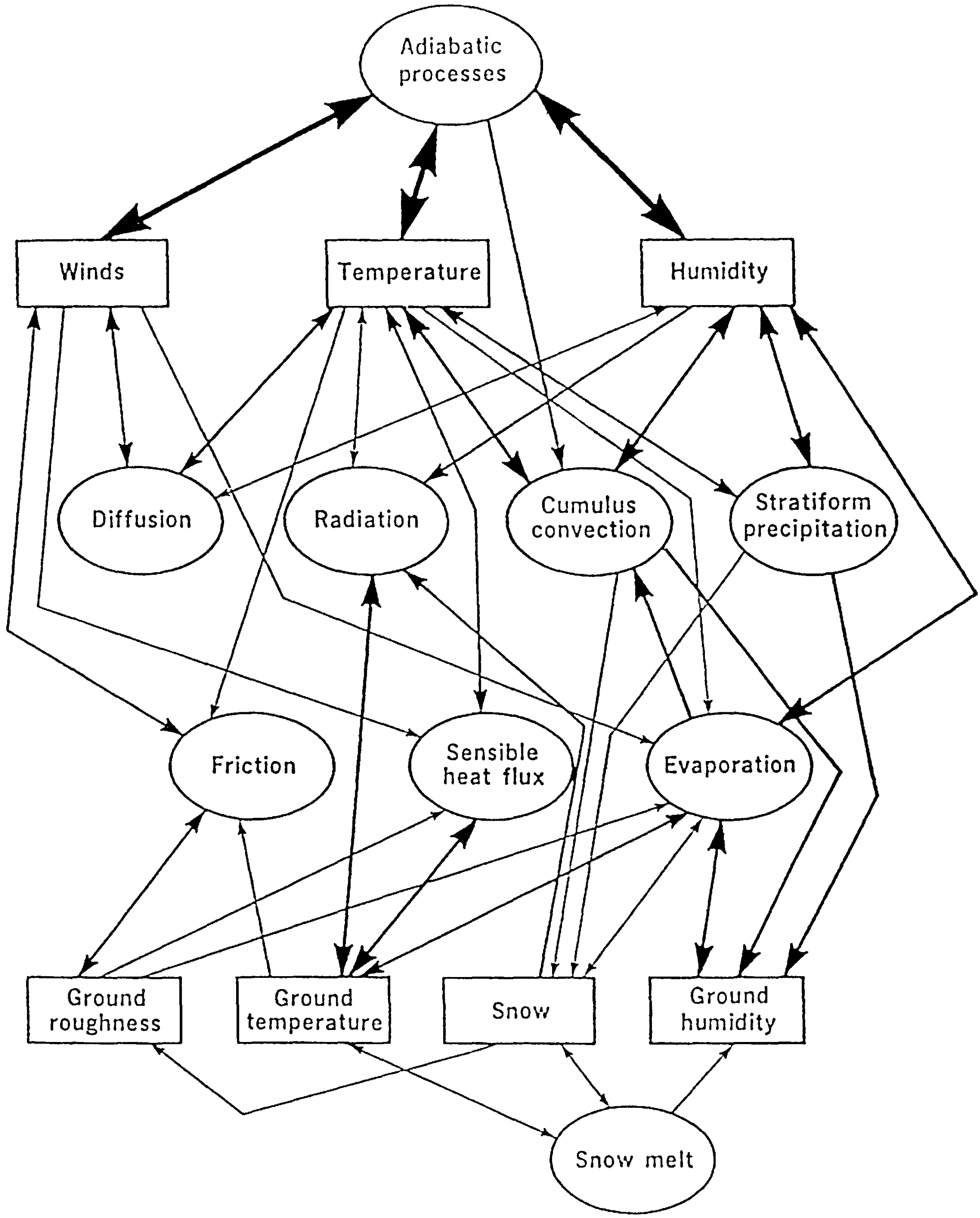
Figure 1:
Atmospheric processes are linked in a complex pattern. The scheme shows the processes and their interactions in the ECMWF model. The thickest arrows mark the main interactions governing the weather.

Figure 2:
History of supercomputer performance. Performances are given in MIPS (millions of instructions per second) to 1975, thereafter in MFLOPS (millions of floating point operations per second).

Figure 3:
Slightly inadequate data describing initial weather over the North Pacific (a), result in growing errors in the forecasts for 2, 4 and 6 days ahead. Full lines mark overestimates of the height where the pressure was 300 mb and dashed lines are for underestimates. The numbers give the errors in decametres.

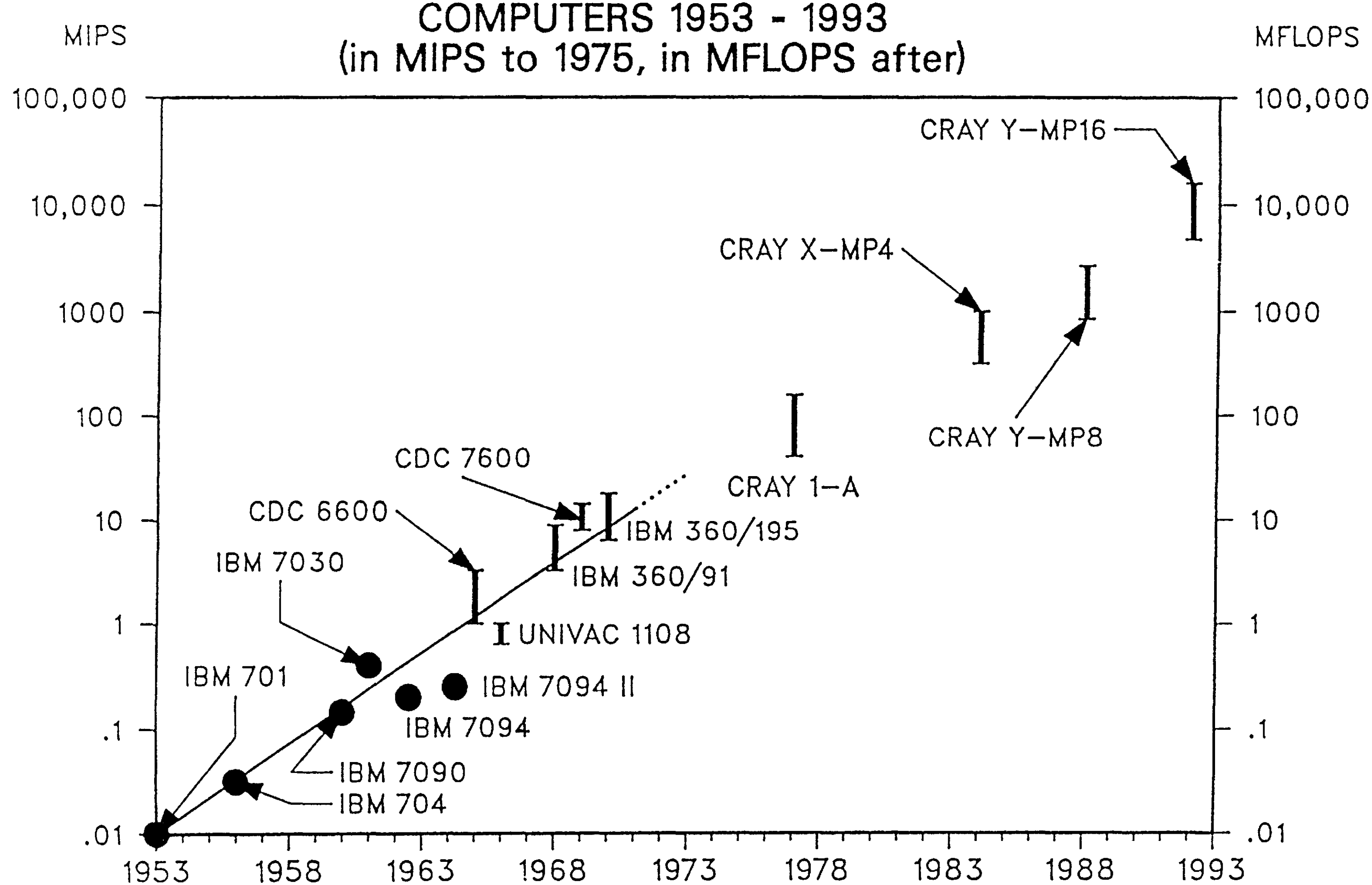
Figure 4
The ECMWF telecommunication system. A dedicated, medium speed, telecommunication network with speeds ranging from 4.8 Kbits to 64 Kbits has been established between ECMWF and its Member States. The lines are used for the distribution of operational products and for the use of central computing at ECMWF by the Member States.

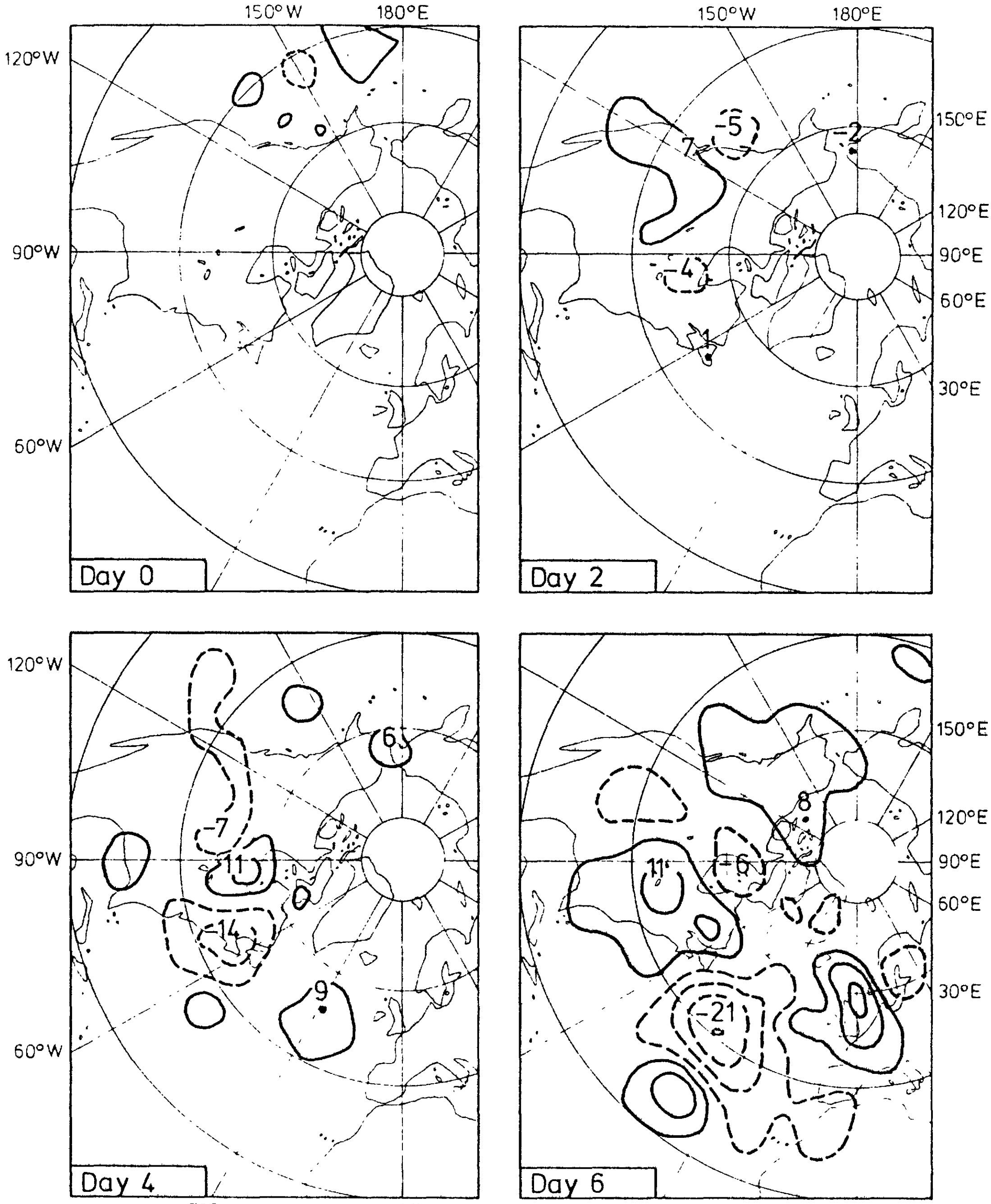
Figure 5
Forecast scores for the deviation from normal climate (at 500 mb or at a height of about 5500 m). 100% indicate a perfect forecast and 0% a forecast proving no skill beyond climatology. 60% is normally considered as a practical limit for useful skill. A pioneering US trial (1972) succeeded for half a week. The graphs for later years show that ECMWF had more than doubled the period by 1989.



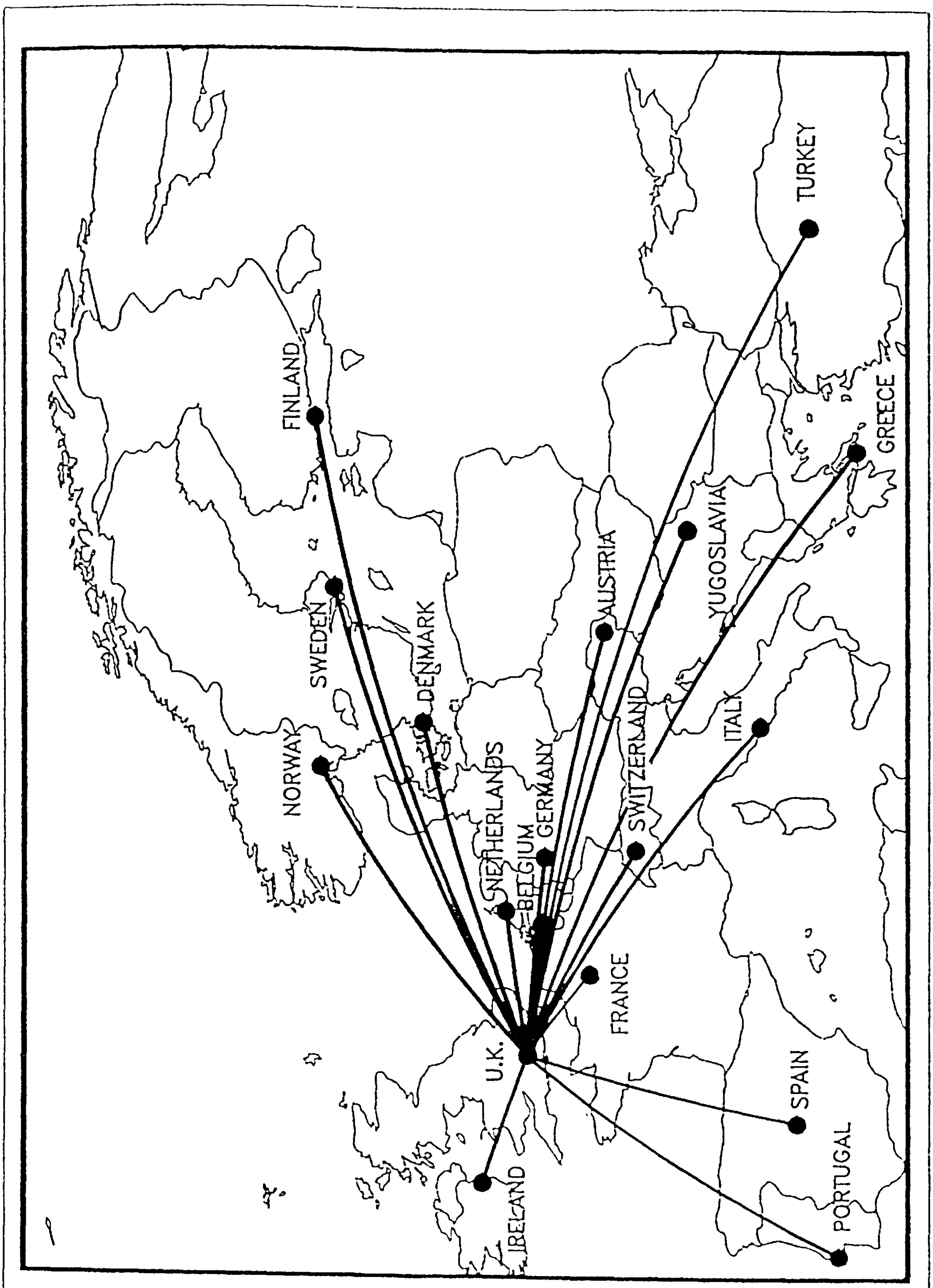
Adiabatic processes
Winds
Temperature
Humidity
Diffusion
Radiation
Cumulus convection
Stratiform precipitation
Friction
Sensible heat flux
Evaporation
Ground roughness
Ground temperature
Snow
Ground humidity
Snow melt

PERFORMANCE OF THE MOST POWERFUL COMPUTERS 1953 - 1993 (in MIPS to 1975, in MFLOPS after)

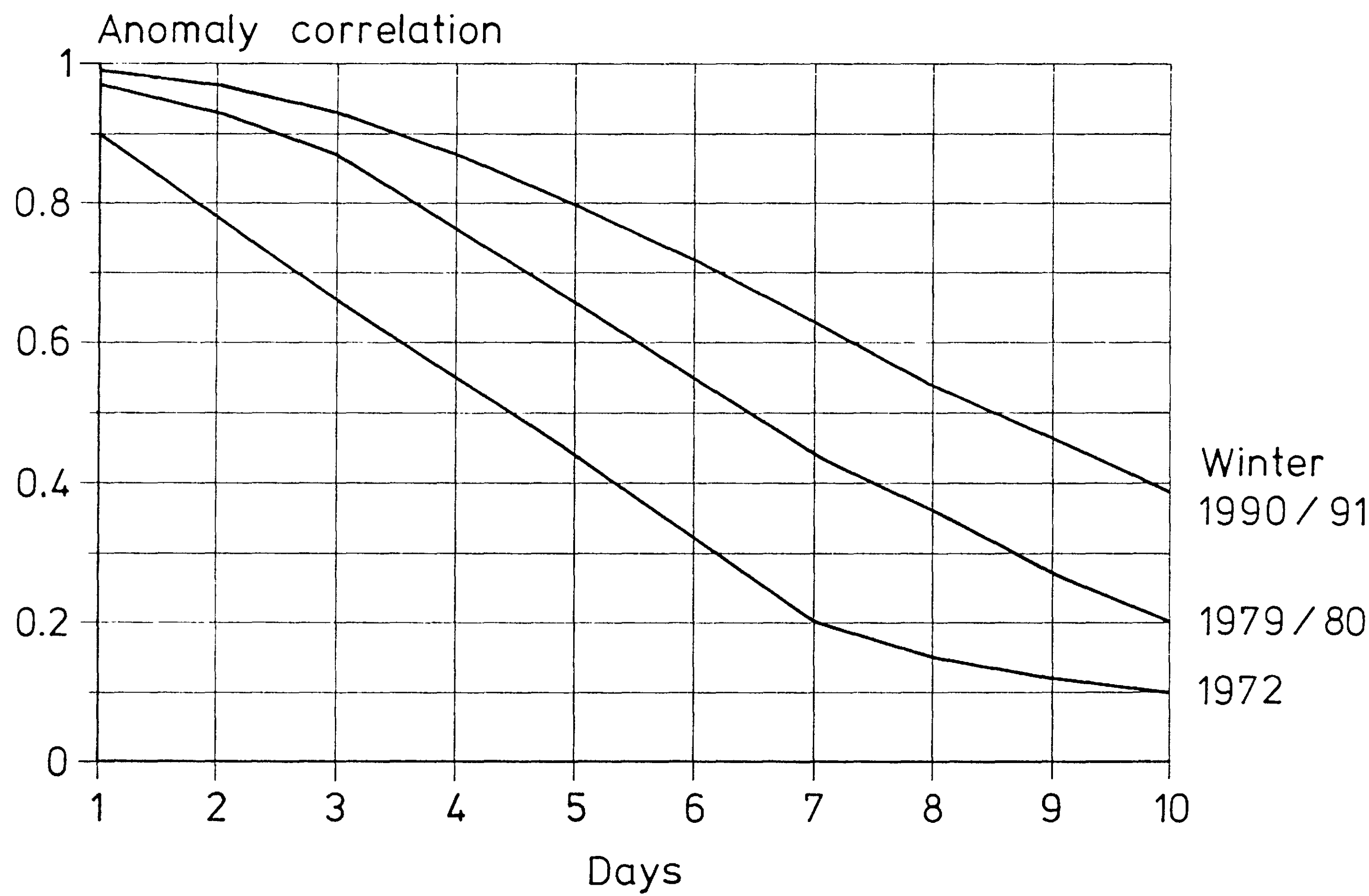




150°W
180°E
120°W
90°W
60°W
Day 0
150°E
120°E
90°E
60°E
30°E
-5
-2
-4
Day 2
-7
11
-14
6
9
Day 4
8
11
-6
-21
Day 6
30°W
0°E


FINLAND
SWEDEN
NORWAY
DENMARK
NETHERLANDS
BELGIUM
GERMANY
AUSTRIA
SWITZERLAND
YUGOSLAVIA
ITALY
GREECE
TURKEY
FRANCE
U.K.
IRELAND
SPAIN
PORTUGAL

NORTHERN HEMISPHERE (DJF)
Anomaly correlation 500 hPa



REPORT

on Proceedings at the

METEOROLOGY WORKSHOP

delivered to the Plenary Session of the

COST FORUM, VIENNA, NOVEMBER 1991

by the Chairman of the

COST ad hoc Technical Committee - METEOROLOGY

Meteorologists, it was pointed out, are no strangers to cooperation; they have been doing it successfully for hundreds of years. Nonetheless it was always exciting when new ways emerged of improving the extent of this cooperation, and COST had been a very successful vehicle in this respect. The current extension of the COST family was warmly welcomed.

As an example of a successful and on-going COST activity, the Workshop heard a detailed account of COST 74 - dealing with Wind Profilers - from the Chairman of the COST 74 Management Committee, M. Marc Gilet of France. There followed from Dr. Pirkko Saarikivi of Finland a description of the three new projects which had been identified by the Technical Committee on Meteorology as being suitable and likely to benefit from COST Action in the near future. These were:

- Nowcasting (very detailed weather forecasting over a short time scale);
- Agricultural Meteorology; and
- Short-range Atmospheric Dispersion of Pollutants.

Four representatives of the new COST member countries also addressed the Workshop - Dr. F. Dombai of Hungary, Dr. A. Wojtach of Poland, and Drs. M. Wolek and P. Havranek of the Czech and Slovak Federal Republic. Each outlined the extent to which their country was likely to contribute to existing and proposed COST projects in Meteorology, and also the benefits that their country could expect to derive from COST membership.

The ensuing discussion was varied and informative. It was clear that the existing members welcomed the prospect of new participants in COST Action, and that the new members for their part were enthusiastic about the possibilities for future cooperation.

Two major points emerged from the discussions:

- There was an awareness that in the past COST projects in Meteorology had emerged "from the bottom up"; they were active projects in which there was already a fair degree of international cooperation and all that was necessary was to formalise this enthusiasm under the COST umbrella. With the establishment of the COST Technical Committee on Meteorology we were entering an era in which potential projects might be identified by a "top down" approach; in some cases the same degree of motivation and enthusiasm might not be in evidence initially among relevant experts in the field. This factor should be kept in mind when assessing possible new projects.

- The COST system was seen as a very cost-effective means of promoting scientific research in the field of meteorology. Significant results were achieved at negligible cost to the EC - particularly when viewed in the context of the funds allocated to Community Programmes. The ability of some of the new member countries to participate in this largely voluntary effort was likely to be severely constrained by the limited availability of domestic resources; indeed many of the existing members were unable to play as active a part in COST activities as they would wish for the same reason. It was felt that this difficulty could be greatly alleviated by a comparatively modest increase in the level of EC resources devoted to COST Projects - perhaps in the form of assistance towards travelling and per diem for Management Committee meetings. Reports that some move in this direction might be imminent were welcomed by the participants in the Workshop.

Brendan E. McWilliams,
Chairman, COST ad hoc Technical Committee - METEOROLOGY
6th December 1991

G. MATERIALS

Workshop "Materials"

Drivers for Material Development in Power Engineering

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Abstract

The work done so far within COST is described in 3 Phases – creating a technology base, widening the scope and focus by the Work Package Concept. These 3 phases constitute a gradual maturing from a technology driven to a market driven materials development effort.

The future will see the beginning of globalization in materials development to reflect the globalization of the power generating industry.

Examples are given for work accomplished so far. Areas of future research for improved energy systems are defined and specific recommendations relating to new materials research are made.

1. INTRODUCTION

Materials research for power generation within COST started in 1971 with COST 50 'Materials for Gas Turbines', which lasted for 10 years. The continuation of this program was COST 501 'High Temperature Materials for Conventional Systems of Energy Generation and Conversion using Fossil Fuels' and COST 505 'Materials for Steam Turbines'.

The work done in the past 20 years can best be described in 3 phases

Phase 1: Creating the Technology Base

In the early seventies European gas turbine industry had a very fragmented technology base. A general awareness of dependence on major new technologies existed, all coming from the USA. To name a few – directional solidification, mechanical alloying, isothermal forging, coating technologies, mechanical metallurgy. After 10 years of cooperation among European companies and research institutes this technology base was firmly established.

Phase 2: Widening the Scope

In COST 501, other energy systems such as fossil fired power plants, diesel engines etc. were considered in addition to the gas turbines. As a consequence the technology base was widened to encompass heat resistant steels, corrosion resistant steels and related manufacturing technologies. While partially successful, this phase pointed out the need for a focus and a new management structure.

Phase 3: Focus – the Work Package Concept.

The second phase of COST 501 was based on an entirely new concept. Driven by long–term needs of the European power engineering industry, work packages were defined and coordinated by industry, leading to the demonstration or feasibility of manufacturing a component – a turbine blade, a rotor, a boiler component. This phase required a new concept of management similar to project management within industry. So far this concept has served its purpose well, and a series of well–focussed projects has been launched.

Limitations and Future Outlook

Attempts to integrate the work package concept into plant demonstration projects have failed so far, most likely because of lack of synchronization of various European and national programs. There is and probably will remain for some time the fragmentation of the European utility industry which prevents radical technological initiatives similar to the Japanese (MITI; CRIEPI) or the US activities (DOE clean coal technology program, EPRI).

On the other hand, European industry is moving into the direction of globalization, as exemplified by my own company. As a consequence, formerly national programs have partially been substituted by

European programs, and a need for cooperation on a global basis can be seen already. COST is well positioned to accept this challenge.

2. DRIVERS FOR MATERIALS DEVELOPMENT UNTIL NOW

COST started 2 years before the oil crisis. There was not yet a strong motive to increase efficiency in order to minimize fuel consumption or to reduce emissions. The only driver was the technological gap between the United States and Europe. Gas turbines were selected because they contained the highest percentage of advanced materials utilizing advanced processing techniques.

The technology push remained the most important element for COST, although the drive to gain higher efficiencies and to reduce emissions gradually became part of the reason behind the program.

3. DRIVERS FOR MATERIALS DEVELOPMENT IN THE FUTURE

The work package concept is a reflection of a more market–oriented approach to materials development. *Increased efficiency* has been the most important motive. For a new round of COST–programs for Power Engineering Materials the *environmental issue* clearly will be the dominating theme. But also the market outlook looks more promising than in the past. For the Western world a growth rate of 2–3%/year in power generation seems to be certain. Together with the replacement market this growth will generate a market for power plants of all types of 40 GW/yr or more. Assuming an average of 1000 US$/kW this translates into a market volume of 40 billion US$/yr.

Besides environmental requirements four key ingredients will determine market success of power plants

- first or capital cost
- efficiency or fuel consumption
- reliability
- maintainability.

Innovative system solutions will result with higher overall efficiency under economic conditions . This efficiency is high if

- top cycle temperature of cycle is high
- bottom temperature of cycle is low
- cycle has reheat and/or regenerative features

- aerodynamic, heat, mechanical and electrical losses are low
- exhaust losses are low.

New energy conversion systems are under development which convert the chemical energy in the fuel directly to electricity and, therefore, are not subject to the Carnot limitation. The most promising one is the *fuel cell*.

If the boundary limits of the energy generating system are expanded to include generation of heat in a certain geographical area, then *co-generation* offers vast untapped possibilities to improve overall fuel efficiency.

The Carnot efficiency goes up if the steam temperature in a boiler or a steam turbine is raised or if the turbine inlet temperature of a gas turbine is increased.

Raising temperatures is possible but requires development work
- for the boiler mostly on the materials side
- for the steam turbine mostly in design and manufacturing but also on the materials side
- for gas turbines on the materials side, but also on improved cooling methods which lower the metal temperature.

Reducing emissions of NOx requires development on the system side, but also improved materials which are corrosion-resistant in both reducing and carburizing atmospheres.

4. Potential of New Materials and New Processing Techniques – Results obtained in COST 501

4.1 Advanced coal fired plants

There is a worldwide effort to develop advanced ferritic steels to raise the steam temperature from 540°C to 600°C.

In **Japan** the motivation for developing high efficiency coal-fired power plants is the total lack of domestic fuel resources. In 1981 the initiative was taken by EPDS (the Electric Power Development Co.) to develop the technology for advanced steam conditions. This program was accompanied by the development of several grades of high-temperature ferritic steels for use in critical components such as rotors, casings, pipes etc. The program proceeded systematically from materials development to component testing in a 60 MW–demonstration plant to the planned erection of a 700 MW power plant.

In the **US**, EPRI has formulated a large scale program to develop key components for an improved coal fired power plant. ABB, through Combustion Engineering, is participating in this program, with the steel T91, a joint development of C–E and Oak Ridge National Laboratory.

The **Soviet Union** which has the largest installed capacity of supercritical units is planning a next phase with a 800 MW supercritical unit involving steam temperatures up to 650°C.

In **Europe**, COST 501 provided the fuel for a concerted materials research effort leading to advanced steel grades. Figure 1 shows a comparison of creep rupture properties at 600°C for several steels originating from both Japan and Europe. Building an advanced steam plant today is less a technical materials issue but more a market question.

An important technological breakthrough has been the application of *powder metallurgy* to produce net shape steam headers(Figure 2). As expected mechanical properties are very homogeneous. But most properties such as notched impact data and LCF are higher than targeted. Powder metallurgy provides both a cost saving for complex components and a decrease in the delivery time for the customer. It is also to be expected that because of the potential of microstructural refinement creep properties and short term mechanical properties of components such as rotors can be further improved.

An important but still speculative area for future research is the development of *last stage low pressure turbine blades* from high specific strength materials. Figure 3 shows the potential for improvement from the currently used 12% Cr steel by titanium alloys which are currently being evaluated, and in the more distant future by composite plastic materials, provided such materials can be protected against water droplet erosion. It is clearly seen that availability of high specific strength materials allow greatly increased design freedom, i.e. to push design limits into new areas.

4.2 Gas turbines

The development of gas turbines has been regulated by the availability of materials and the ability to process them into useful shapes. Materials development for high-power industrial gas turbines follows different lines to those for aircraft engines:

– Design life for industrial turbines is up to 10 times longer.

This requires either reduced design stresses and temperatures or alloys with longer lives for a given combination of stress and temperature.

– Because low-grade fuels are burnt in industrial gas turbines, more sulphidation resistant alloys containing higher amounts of chromium have to be used. Chromium degrades the strength of superalloys because it reduces the maximum amount of strengthening phase, γ', in the alloys.

– Component size in industrial turbines is much larger.

This affects the processing technologies and their economics which can be applied. *Single crystal alloys* offer the highest potential at intermediate temperature, provided the alloys have been designed in such a way that by removing grain boundary strengthening elements such as B, Hf, Zr and C the incipient melting point of the alloy can be raised. This increase is sufficient to permit an optimization of fine γ'–volume fraction. Single crystal turbine blades are state–of–the–art in aircraft engines, but several problems have to be overcome if they should also be used in industrial gas turbines (higher chromium content, processing of larger components). It is not surprising that at first the *DS blades* have been introduced into industrial turbines. Several experimental alloys exist with properties that are clearly superior to conventionally cast IN738. Blade sizes of 20mm are manufactured in large quantities for smaller gas turbines in the USA and in Europe. It is, however, still a goal to further develop the processing technology to such a stage that blade lengths of 400–600mm could be obtained.

A good example of a successful development of a new superalloy is NFP 1916, an alloy developed by ABB. Initial development was sponsored by a Swiss National Research Fund, leading to a specific alloy composition. Subsequently this alloy was introduced into COST 501, and is currently being evaluated together with several other commercial and experimental turbine blade alloys. If successful this

alloy will replace IN738 in some of the stages of land-based gas turbines.
Alloys which ought to be ideally suited for industrial gas turbines are
oxide dispersion strengthened alloys. While the low alloyed nickel-base alloy MA754 is used in fairly large amounts for vanes in jet engines, higher alloyed compositions such as MA6000 have only reached the advanced experimental stage. Component manufacturing technologies must be scaled-up to larger sizes. Just as for directionally solidified alloys ODS superalloys rely on a high thermal gradient which needs to be established during zone annealing of the alloy. The COST 501-program contributed to a great extent to the further development of ODS alloys and to a better understanding of life-limiting factors.

5. What are the material classes to be investigated next?

The answer to this question should define the next COST-program for Power Engineering Materials.

5.1 Intermetallic Alloys

Recent results from the German MatFo-program, but also from Japanese, US and other European program suggest, that the TiAl-class of alloys has the highest potential to be further developed and selected as blade materials. The principle application of these alloys is seen at temperatures up to 700°C. Because of their low specific weight and the high specific strength they have the potential to replace the heavier superalloys, thereby reducing the load on the rotor. A COST-program should focus on

- the selection of an alloy composition providing reasonable ductility
- the selection of a suitable economic manufacturing technology. Candidate technologies are precision vacuum casting and HIP of high-purity atomized powder.

5.2 Ceramics

Engineering ceramics still has a long way to go until it finds use in industrial gas turbines. There have been demonstrations of ceramic gas turbine vanes in the Japanese Moonlight Program, but very little has been done in Europe. Time has come to seriously address these issues and discussions are underway in Europe to start a joint program to design ceramic turbine components.

5.3 DS/SC Technology

Tasks have been started in COST 501. Considering that the requirements for new gas turbines are continuously revised upwardly, major efforts will be needed to

- design new superalloys by improved computer–models
- evaluate new alloys
- Manufacture increasingly larger components without casting defects.

More than any other class of materials it will be the *superalloys* which for the next 10 years will limit the progress in gas turbines. This may sound surprising to many in the research community, but it is a fact. It also requires a commitment to continue work on superalloys within COST with high priority.

5.4 Materials for Clean Coal Technologies

There are many competing coal technologies each posing different challenges for advanced materials.
The most important ones:

- Materials for the next generation of PFBC
- Hot gas clean–up for PFBC and IGCC.
- Materials for Low NOx boilers.

Study groups have been assigned to help to define work packages for most of these projects.

6. Concluding Remarks

COST has provided continuity in high temperature materials research for power engineering applications in Europe. It has accomplished more in this field than any European or national program. COST 50/500/501 also have had a remarkable stability in management. It is mandatory for the ambitious and difficult tasks of the future to secure the continuity of the effort and to provide a professional management support.

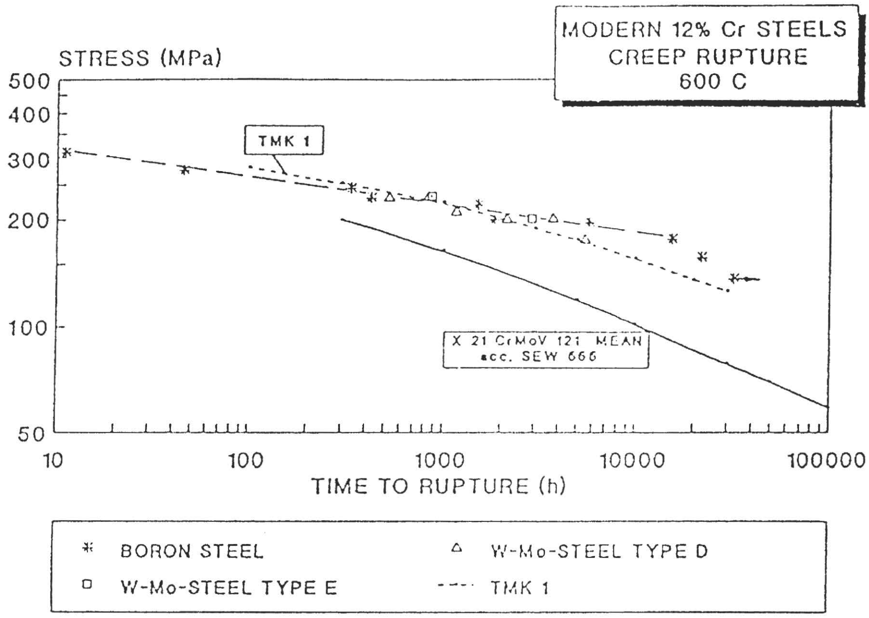

Figure 1 Modem 12% Cr steels; creep rupture at 600°C.
(Ref. R.B. Scarlin, COST 501 results (1990)

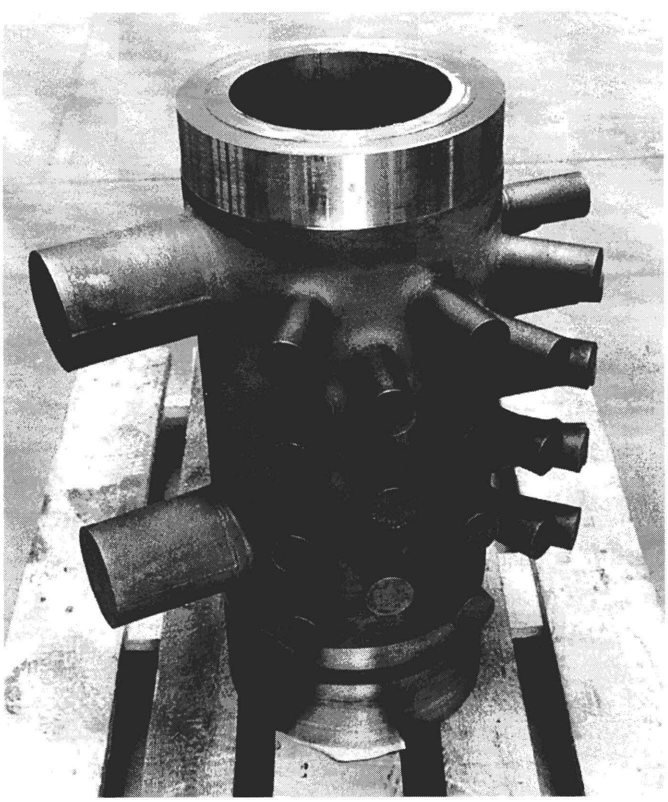

Figure 2
Header specimen for steam boiler
(Ref. K. Torssell, COST 501 results, 1991

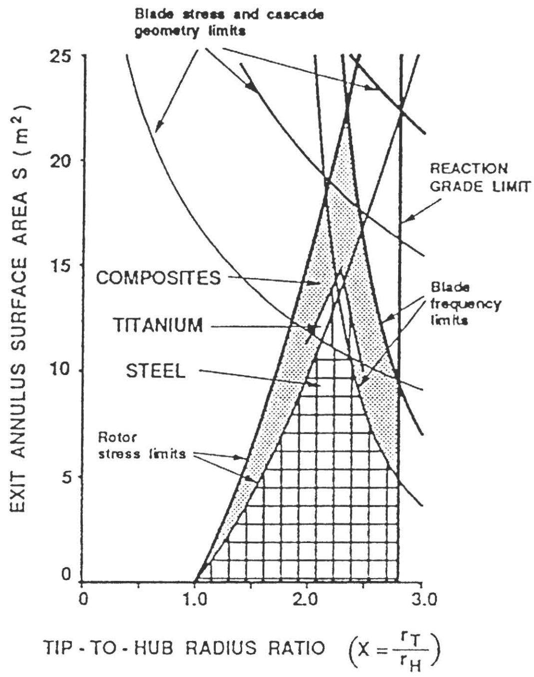

Figure 3 Calculated design limits in the X–S plane for steel, titanium and composite blades for 3000 rpm LP turbines (Ref.: Gyarmathy, Schlachter; Conf. Technology of Turbine Plant Operating with Wet Steam, BNES, London, 1988)

From Gas Turbines to Micro-Motors: New Perspectives for Materials Science

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Abstract

In this contribution a former and present participant in the COST materials programmes attempts to look beyond current materials problems, as epitomized by the gas turbine, and to describe possible new perspectives in the emerging field of "micro-machines" (with characteristic dimensions of 1 mm and less). It is shown that, as in the turbine technology, the realization of micro-machines will eventually depend on suitable high-tech materials. However, many new effects and interesting properties associated with materials in small dimensions are as yet unexplored.

1. Introduction

The evolution of the gas turbine is a classic example for the interdependence of design and material: over the last decades, new high-temperature materials have improved the performance of jet engines and stationary power turbines, which in turn has spurred the development of new materials. This symbiosis of interests has led to an almost unparalleled research and development effort, with many developments still to be expected. Materials research within COST over the past twenty years has contributed substantially to the current achievements, by exploiting two particular fortes: i) cooperation between industrial laboratories and academic institutions, and ii) international collaboration. COST has thus proven the point that such collaborations, despite language barriers and other "dissipative" losses, are worthwhile or even instrumental to the pursuit of ambitious scientific and technological goals.

The intention of this contribution is to look beyond current materials problems, like those of the gas turbine, and to describe some possible new perspectives for future materials research. The example chosen is the author's new field of research: materials for micro-applications, such as micro-motors that would fit inside a human hair or a blood vessel. Of particular interest are "structural" materials from which active components in future micro-sensors or microactuators might be produced. The emerging field of "micromechanics" or "microdynamics" is now receiving substantial funding from the U.S. and the Japanese government.

Its application potential, uncertain as it may appear today, will most likely lie in fields such as micro-surgery, robotics, space exploration and special sensors.

The quintessence of this paper can be summarized as follows: like gas turbines, the realization of efficient micro-machines will eventually depend on the availability of materials with tailor-made property spectra. In order to provide these materials, large-scale fundamental research will be necessary. As will be shown, almost all aspects of research into micro-materials - from processing and microstructural manipulation to mechanical testing and fundamental explanation of specific properties - will require innovative methods and creative application of modern materials science concepts. The following chapters touch on some of these aspects.

2. Mechanically Stressed Micro-Components: Some Examples

Miniaturization of components has not only revolutionized electronics, it has also entered the field of mechanical design /1,2/. Over the last few years, moveable micro-components have been produced using methods akin to microelectronic VLSI processes. Some examples, which stress the importance of well-defined materials properties, will be briefly discussed.

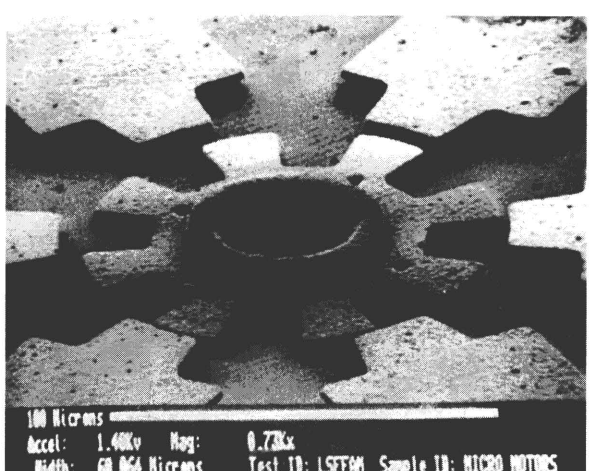

Fig. 1: A micro-motor produced from polycrystalline silicon /8/. The rotor diameter ist about 0.06 mm

Current micro-motors consist of moveable rotors with characteristic dimensions in the range of 0.1 mm, e.g. /3,4,5,6/ and are driven by electrostatic actuator systems. A typical example, produced from polycrystalline silicon, is shown in fig. 1. Silicon, as a "ceramic" material, has interesting mechanical properties /7/, but its choice is mainly motivated by the availability of processing methods. Other designs /8/ use nickel, again mainly for processing reasons. Mechanical failure in the form of motor or bearing damage is still quite common when these wheels are spun at high frequencies for extended periods of time.

Another example is a non-volatile mechanical memory cell /10/ produced by patterning micro-bridges (typical dimensions: 30x5x1 µm) into a thin film. Provided compressive film stresses exist, the bridges, when released by etching, buckle out of the plane of the film and store information: "1" for buckling "up", "0" for "down". Applying an electric field allows changing the memory content, reading is accomplished by a local capacitance measurement. It is immediately obvious that the material for the micro-bridges will have to fullfil certain mechanical requirements: high yield stress in order to prevent plastic deformation during the switching event, low elastic modulus to obtain low switching voltages, and good fatigue resistance in order to allow switching cycles in excess of current EPROM capabilities. This is a definition of a classic materials development programme, which should lead to an optimal choice in keeping with processing requirements.

In conclusion, these two examples show that in the field of micro-components, materials with well-defined mechanical properties are likely to become of great importance. Even for more "conventional" components, such as metallic conductor lines in integrated circuits, mechanical performance is becoming increasingly critical as miniaturization proceeds further: failure of these lines is intimately connected with mechanical stresses /11/. It is therefore urgently necessary to understand the mechanics of materials in small dimensions.

3. Mechanical Testing and Properties in Small Dimensions: Some Selected Aspects

In order to test the suitability of certain materials in micro-applications, the properties of micro-components produced from candidate materials as well as the precursor structure (usually a thin film deposited by CVD or PVD processes) need to be characterized mechanically. The common tension test, when applied to thin films, meets with great experimental difficulties due to gripping problems, although it is being used by some groups. Novel methods thus need to be established; this field of testing thin films is currently under rapid development, as is evidenced by two recent symposia /12,13/.

A device for determining the local mechanical properties of thin films and micro-components is a mechanical "microprobe" (e.g. a "nanoindenter" /14,15/): a sharp diamond tip is pushed continuously into the material and the force is measured with high resolution (in the μN range). This allows extremely shallow indentations to be made, several orders of magnitude finer than in conventional hardness testing. At the same time, the penetration depth of the indenter tip is monitored, again to a high degree of precision (less than 1 nm). From this information, collected during both loading and unloading, the hardness (and thus the flow stress) as well as the elastic modulus can be determined. A variant of this method is to deflect membranes or micro-beams which have been produced by selective etching of the substrate.

Another example of a micro-mechanical test method, applicable to thin films, is the curvature measurement, e.g. /16/. In this technique, the bending of a substrate due to mechanical stresses in the film deposited on its surface is accurately measured, for example with a laser technique. From the radius of curvature and the elastic constants of the substrate, the stress in the film can be evaluated. By changing the temperature, different stresses can be obtained because of differential thermal expansion of the substrate and the film. A typical result of subjecting an aluminium film (about 0.5 μm thick) on a silicon substrate to a thermal cycle between room temperature and 450 °C is shown in fig. 2.

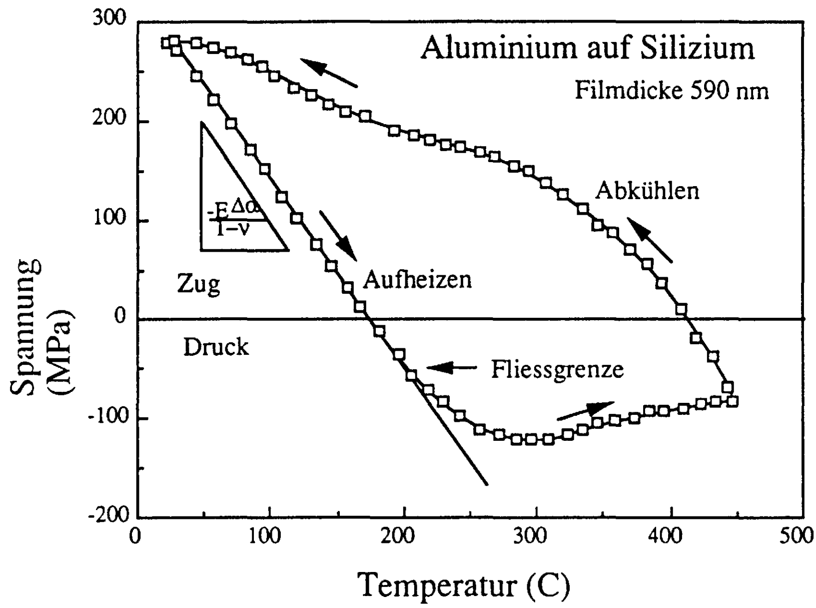

Fig. 2: Typical stress vs. temperature curve for an aluminium film on silicon, cycled from room temperature to 450 °C. Note the abnormally high strength of the pure aluminium (> 100 MPa), even at high temperatures - a "thin film" effect that is important for micro-components.

At the start of the experiment (at room temperature), the film is subjected to a considerable tensile stress (about 280 MPa). As the temperature is raised, this stress decreases linearly (corresponding to the elastic behaviour of the film material) until it enters the compressive region. The compressive stress shows a non-linearity near 100 MPa, which suggests plasticity occurring in the film. With further increases in temperature, the plastic flow stress of the film decreases only slowly. Subsequent cooling to room temperature produces the "hysteresis" shown in the figure.

Many details of this curve are unexpected and not well understood. What is particularly striking is that the flow stress measured for the aluminium thin film by far exceeds the flow stress of "macroscopic" aluminium samples, especially at high temperatures. This and similar other results have an important consequence for micro-components: materials may, on a micro-scale, have substantially different mechanical properties. Simple transfer of material data from a "macro-measurement" into the "micro-world" is at least questionable.

The scientific explanation of such effects is only cursory at present. The reason for the above-mentioned strength enhancement most likely lies in the constraints for the movement of lattice dislocations, which in crystalline materials are the carriers of permanent plastic deformation (fig. 3). In a thin film, such a dislocation has to bend to a high curvature in order to move and to effect deformation. First models developed along this line, e.g. /17/, show that this process requires high stresses, which scale inversely with the film thickness and have reasonable order of magnitude. Many details however have yet to be explored in order to understand the peculiarities of some properties, such as strength or - to mention another important criterion - toughness, encountered on a small scale /18/. In addition, a great number of complications arise in micro-materials: intrinsic stresses, high interface density, non-equilibrium states, to mention but a few. Only successful fundamental research is likely to provide the rational basis for the design of future micro-machines - perhaps one day in much the same way as present-day gas turbines.

4. Concluding Remarks

Materials science is just coming of age, with many new and unexpected challenges waiting "around the corner". The example described briefly in this contribution contains all the ingredients of an innovative research programme. It is and will undoubtedly be reflected in research proposals and national programmes. Whether its promises will come true and its potential can be exploited is utterly uncertain and can at best be the subject of speculation - a sufficient motivation for fundamental research.

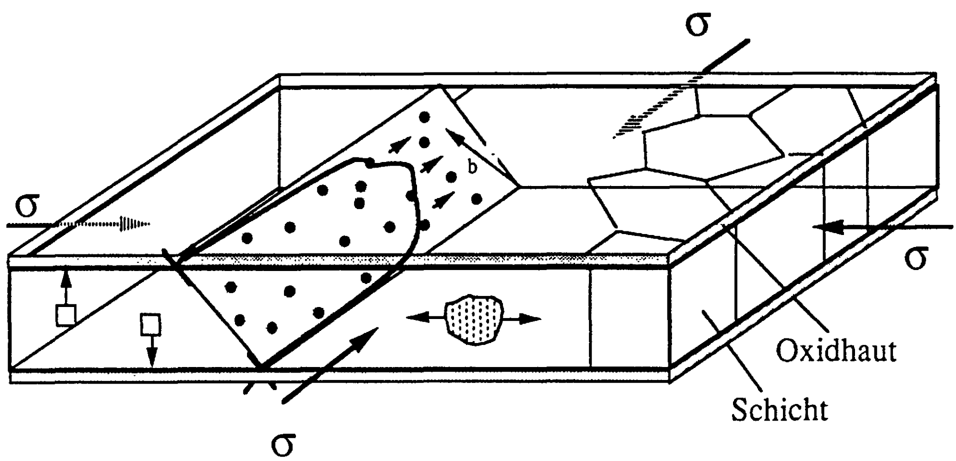

Fig. 3: The geometric constrains in micro-materials can give rise to new mechanisms and "abnormal" behaviour which is not expected from macroscopic measurements. The rational design of future micro-machines will have to take these effects into account.

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Technical Committee on Materials (COST)

COST Forum,
Workshop on Materials Vienna,
November 22, 1991,
Summary

30 experts from 15 COST member states attended the workshop, among them 7 representatives from Czechoslovakia, Hungary and Poland. The main topics of running COST actions on materials and of those in preparation were shortly presented by the chairman (s. enclosure).

Experts from new COST member states reviewed their R & D fields in materials. The topics covered engineering ceramics, iron castings, corrosion research, Al and Al_2O_3 based materials, surface engineering and control of microstructure of metallic materials. Most of the topics fit well into running (a Czechoslovakian institute is already involved in COST 504) or planned COST materials actions. However, only in a few cases manpower, equipment and R & D budget opens the possibility for intensive cooperation with partners in the old COST member states, at least on a short term scale.

In order to strengthen the public relations of COST materials activities representatives from major European materials research organization have been invited (E.M.R.S., f.e.m.s, EPMA). As a result of a short discussion COST will play an even more imported role in their conference planning, newsletters etc.

Including the contributions from the plenary talks on "Drivers for materials development in power engineering" and "From gas turbines to micro-motors: new perspectives for materials science" research in materials science and technology continues to be of crucial importance for advancement of knowledge as well as for industrial efficiency with respect to technology, economy and ecology. The trademarks of concerted COST materials activities are

- precompetitive R & D of industrial relevance and industrial participation,
- concentration on essential topics via bottom up approach and participation "à la carte" and
- flexibility with respect to participants from non COST member states.

Those trademarks guarantee a high ranking of COST materials actions within European R & D activities in the field of materials - also in the future.

Eberhard Seitz

Dr. E. Seitz
Chairman, Ad Hoc Technical
Committee on Materials

encl.: two appendices

CURRENT COST MATERIALS ACTIONS

COST Action	Topic	Number of partici-pating countries	Number of Projects	MY	Duration	Total Costs MECU
501/II	Advanced materials for power engi-neering components	14	196	560	1988-1992	44.0
503/II	Powder metallurgy	9	41	225	1988-1991	15.0
504/III	Advanced casting and solidifica-tion technology	10	30	150	1991-1994	9.0
506	Industrial appli-cation of light metal alloys	9	32	105	1988-1991	7.5
507	Thermodynamic data for light metal alloys	12	33	105	1989-1992	4.0
508	Wood mechanics	11			1990-1992	
509	Corrosion and Protection of Metals in Contact with Concrete	6			1991-1993	

Technical Committee on Materials (COST)

Proposals for new COST Materials Actions
approved by the Committee of Senior Officials

- Advanced Materials for Temperatures above 1500 °C
  - Development of Testing Methods (COST 510)
- Interaction of Microbial Systems with Industrial Materials (COST 511)

Proposals for new COST Materials Actions
approved by the Technical Committee on Materials

- Modelling in Materials Science and Processing
- Improvement in Availability and Quality of Intermetallic - Based Materials

Proposals under discussion

- Plasma and Ion Based Surface Engineering (PISE) Techniques for Materials

  (November 25, 91; Paris)
- Ferroelectric Ceramic Thin Films
- Cleaner Metals
- Polymers with Electrical, Optical and Magnetic Properties
- Tribology
- High Pressure Materials Research

Further topics appropriate for COST are welcome!

H. TELECOMMUNICATIONS

Presentation of Telecom activities

OVERVIEW OF COST ACTIVITIES IN THE FIELD OF TELECOMMUNICATIONS

The Technical Committee Telecommunications (TCT) started in 1971 proposing three projects. A great number of projects touching the various aspects of telecommunications was then set up and completed.

The results were very stimulating and can be considered as the corner stone of the European research in telecommunications. All the European initiatives created subsequently profited beneficially of the precompetitive research carried out in COST. TCT started in the years a fruitful collaboration with CEPT, ETSI, CCITT, CCIR and other standardization bodies. Commission programmes, EUREKA and EURESCOM utilized the results of the COST researches and also started some relationship with COST TCT.

There are nineteen telecommunications projects running at present. The COST telecommunications undertook research in particular in the fields of :

- Telecommunications Networks
- Signal Processing
- Radio Communications
- Television
- Optical Fibres
- Teleinformatics
- Satellite Communications
- Radiowave Propagation
- Antennas
- Human Factors in Information Services
- Mobile Communications
- Multimedia
- Special Applications (Disabled, Security, etc.)
- Speech Processing
- Etc.

Basic Concepts for Radio

Communications in COST

Joseph M. Dwyer,

Chairman,

COST Technical Committee Telecommunications (TCT)

1 INTRODUCTION

COST which stands for European Co-operation in the field of Scientific and Technical Research has been a framework for the preparation and implementation of European projects involving applied scientific research since its establishment in 1971. Telecommunications has always been an important part of the activities of COST, starting with the commencement of the first three COST telecommunications projects at the birth of COST in 1971. Since that time a total of 21 COST telecommunications projects have started and completed their activities, and currently a further 19 projects are operational.

This paper refers to COST telecommunications activities in general, and the arraignments for the development of proposals for COST telecommunications projects and the implementation of operational projects. It goes on to describe the role which radio communications has played in COST telecommunications activities and the basic concepts in this regard.

2. Nature of COST Telecommunications

COST telecommunications activities are pursued by means of the implementation of individual self contained COST projects, each one dealing with a particular technological area. For each individual COST project the form of co-operation is defined in a simple purpose - built agreement called a Project Memorandum of Understanding (MOU) which is signed by the project participants and constitutes the basic document describing the objectives and nature of the project.

Basically a COST telecommunications project is characterised by a combined co-operative attack on a research area of common interest by participants from a number of COST European countries, and a minimum of four, and the exchange of the project results among the participants. Thus it is possible to achieve more efficient use of the resources available for research in a number of countries, and also to obtain more interaction between the researchers in the various countries. Each project participant finances its own share of the project activities and no funds cross frontiers, and also there is no central fund available to support project implementation. The Commission of the European Communities provides the Secretariat of a COST project, free of charge to the project, and a limited amount of funds for the production of reports and the holding of special Workshops and Seminars.

COST projects in general aim to promote basic applied scientific and technical research and are in the nature of pre-competitive research, falling somewhere between fundamental research and development work aimed at defining new products. There is however a flexibility within the COST framework which allows a variation in the position of COST telecommunications projects over this range, with some projects tending to be near to fundamental research and others close to the development of new services and products.

Usually COST telecommunications projects are used to progress and co-ordinate research programmes, either existing or proposed, at a European level, dealing with problems and activities of a basic type which fall under the following headings:

(i) problems which are intrinsically of an international dimension;

(ii) problems which exhibit similarities for a number of countries and where these are amenable to combined actions; and

(iii) problems which when solved provide inputs for harmonisation at the European level, (CEPT and ETSI) or at the global level (I.T.U. and ISO).

3 DEVELOPMENT OF COST TELECOMMUNICATIONS PROJECTS

The COST Technical Committee Telecommunications (TCT) plays a major role in the development of new COST projects in the telecommunications and tele-informatics area. The Committee continually examines the requirements and the possibilities and initiates actions where considered appropriate. Specific proposals for new projects are considered by the Committee and subject to its approval. The Committee is then responsible for sending on a Memorandum of Understanding (MOU) for the project to the COST Committee of Senior Officials for final approval.

The approved project is made available for participation by interested countries and it is ready to become operational when at least four COST countries have signified their intention to participate. The representatives of the participating countries arrange for their countries to officially join the project by signing the project Memorandum of Understanding. The

Commission of the European Communities then arranges for the first meeting of the Project Management Committee to which representatives from all COST member countries are invited. Countries which did not join a project at its commencement may join it within six months of commencement without reference to the Project Management Committee, and thereafter with the agreement of the Management Committee.

4. Development Methods

The Technical Committee Telecommunications employs various methods in its task of developing concepts and proposals for new telecommunications and tele-informatics projects. Seminars and special meetings are held from time to time to which appropriate experts are invited. Also the Chairman of the Committee and other Committee members attend seminars, conferences and meetings to explain the concept and possibilities of COST actions, and to identify potential COST projects.

The Committee sets up from time to time special working parties in order to assist it in its task of identifying and developing COST projects in specific technology areas. At present two such working parties are active, the Working Party on Project Development in the Satellite Communications Area and the Working Party on Project Development in the Tele-infomatics Area.

When the Technical Committee Telecommunications (TCT), considers that a proposal for a particular project has sufficient merit to warrant further development of the proposal, and later the production of a draft Project Memorandum of Understanding (MOU) for future examination by the Committee, it assigns a provisional COST project number, and appoints a co-ordinator for the development of the proposed project. The Co-ordinator is assigned the role of arranging for the evolution of the specific proposal taking into account various inputs received, the production of the draft Project Memorandum of Understanding (MOU), ascertaining and encouraging interest in participation in the project from among the relevant experts and entities in the various COST countries, being the contact person for information on the project concept, proposal and expected work programme, and generally fostering in various ways the development of the proposed project up to the commencement of project operations.

5. PARTICIPATION IN COST TELECOMMUNICATIONS PROJECTS

Participation in a COST telecommunications project is on a country basis and the project Memorandum of Understanding is signed by a representative of the Government of the country. The actual participant or participants in the project from within a particular country is a matter for the appropriate government department or agency, which has been given overall responsibility for COST matters.

In many cases the project participants have in practice been identified or made themselves known by the time project operations commence. They may have been actively involved in the formulation and development of the project proposal via membership of a special working party or otherwise, or have been in contact with the Co-ordinator for the proposed project, or by other means have become interested in the proposed project. Thus at or before the time the approved project is made available for participation by intended countries, these potential participants make the responsible authorities in their particular countries aware of their interest in joining the project.

Because of the nature of COST telecommunications projects it follows that the project participants are mostly drawn from telecommunications administrations and operating companies, and agencies, institutes and research centres belonging to the public sector and the universities, but there is also participation from industry although this is somewhat limited.

6. PARTICIPATION FROM NON COST EUROPEAN COUNTRIES

Participation in COST projects is possible from non COST European countries and for some time there has been participation from Czechoslovakia in the COST telecommunications project COST 219 and from Hungary in the COST telecommunications project COST 226, and participation in other telecommunications projects is expected in the near future.

Three main conditions apply to such participation as follows:

- participation is from individual entities, organisations or institutes and not the country as such as in the case with COST member countries;

- participation is decided on a case-by-case basis, and is subject to approval by the COST Committee of Senior Officials (CS0);

- there should be mutual benefit for participants from COST and non COST countries.

7. Management of Projects

Each COST telecommunication project has a Management Committee (MC) which is responsible to project signatories for the management of the project and its tasks include the following:

- the selection of the research work;

- the detailed planning of programmes;

- the exchange of information on current research and on the results of the project;

- co-ordination with other projects both within COST and external to it;

- the consideration of proposals for project amendment or extension;

- the preparation of interim and final project reports.

Typically a Management Committee is composed of one or two members from each signatory country, with a Chairman being one of the members elected by the committee, and a Secretary supplied by the Commission of the European Communities. The committee meets on average two to four times a year, and may have working to it sub-committees, working parties or task forces, in order to progress, programme and co-ordinate the activities of the project.

The COST Technical Committee Telecommunications (TCT) holds a special meeting about June of each year at which the chairmen of the Management Committees of telecommunications projects report to and discuss with the Technical Committee Telecommunications on the progress of their projects, and discuss such matters as problem areas, methods of working, the establishment of priorities, the work programme for the next year, the need for project change of direction or prolongation, and the attainment of the various project objectives. In addition ideas or proposals for future COST telecommunications projects are discussed. The meeting also serves to deal with matters of general co-ordination between the various projects.

With the increase during recent years in the number of COST telecommunications projects being implemented, more specific co-ordination is now required between some projects, where project technologies converge or impact, in order to avoid duplication of effort, and to facilitate the timely transfer of useful inputs between projects. This co-ordination is effected in a number of ways, and involves regular contacts between the Chairmen of the Management Committees of the particular projects, and in some cases the holding of special or regular Project Co-ordination meetings.

8. Role of Radio Communications

COST telecommunications actions started in 1971 when COST was established with the commencement of the following three projects dealing with different aspects of radio communications technology:

COST 25/1: Aerial Network with Phase Control
Implemented: Nov. 1971 - April 1977
M.C. Chairman: E.F. Bolinder, Sweden

COST 25/2: Aerials with Reduced Side Lobes and maximum G/T Yield.
Implemented: Nov 1971 - Dec 1976
M.C. Chairman: J.W.A. Van Den Scheer, Netherlands

COST 25/4: Influence of the Atmospheric Conditions on Electromagnetic Wave Propagation at Frequencies above 10 GHZ.
Implemented: Nov 1971 - Oct. 1978
M.C. Chairman: F. Fedi, Italy

These pioneering projects have established COST as an important body for European collaborative research and development actions in the radio communications field, with special emphasis on antenna development and radio propagation studies. Two of the Management Committee Chairmen for these first COST telecommunications projects are still very active in COST, Professor Bolinder as the Management Committee Chairman of the currently operational project COST 223; Antennas in the 1990s - Active Array Antennas for Future Satellite and Terrestrial Communications, and Professor Fedi as a member of the COST Technical Committee Telecommunications (TCT).

The important role of radio communications in COST Actions is evident from the fact that 8 of the 21 COST telecommunications projects implemented from 1971 to date deal with radio communications technology and 4 of the 19 telecommunications projects currently operational are involved in radio communications.

The COST method of operation has attractions for collaborative actions in the radio communications field. COST projects can involve participants from a wide range of establishments spread over the various European countries and thus address in a comprehensive manner the European dimension of the various technical problems encountered. The projects can concentrate on dealing with the basic technological factors rather than being focussed on service and product development. Developments in radio communications inherently transcend national boundaries and are international in character. Also standardisation and regulatory matters are important from the beginning of the technical approach and international collaborative research and development can be a powerful impetus to obtaining competent and timely actions in this regard.

The arrangements for the management of COST projects lend themselves to dynamic and effective collaborative actions which are particularly suitable to radio communications. The researchers themselves are in control of the project with the freedom to explore, develop and orient the project, depending on the results which have been achieved and the requirements which emerge from time to time. They operate within the framework of the definition and objectives for the project set in a somewhat general way by the project Memorandum of Understanding (MOU), and subject to the management of the project Management Committee (MC) composed of people drawn from within the project itself.

9. Radio Communications Projects - Radiowave Propagation

The various radio communications projects which have terminated and those which are currently operational fall into three general areas:

- radiowave propagation;
- antenna development, and more recently the development of array antennas; and
- mobile radio development.

Three COST projects on radiowave propagation topics have been conducted during the 20 year existence of COST and a fourth has recently started up. These projects have concentrated on terrestrial paths above 10GHZ, earth - space paths above 10 GHZ, interference paths above 1GHZ, and now on wideband paths and millimetre wavelengths.

The three projects which have been implemented to date were:

COST 25/4: Influence of the Atmospheric Conditions on Electromagnetic Wave Propagation at Frequencies above 10 GHZ:

This operated from 1971 to 1978, and concentrated on terrestrial communications systems, producing a more comprehensive database of radio propagation and associated meteorological data for Europe than would have resulted from individual national efforts.

COST 205: Influence of the atmosphere on Radiopropagation on Satellite Earth Paths at Frequencies above 10 GHZ:

This operated from 1980 to 1985, and collated and assessed the results of European activities in the field of earth - space propagation at frequencies between 11 and 18 GHZ. It produced a comprehensive database and assessed prediction models for the European areas which contributed to CCIR Reports and Recommendations, and to planning future European satellite systems in the above frequency range.

COST 210: Influence of the Atmosphere on Interference between Radio Communications Systems at Frequencies above 1GHZ:

This operated from 1984 to 1990, and set up many new measurement paths and analysed the data received. These, combined with the development of some earlier data, led to a new procedure being recommended and had an impact on the work of the CCIR.

The most recent project has just started operations and will be implemented over the period 1991 to 1995. This is COST 235, Radio Propagation Effects on New Generation Fixed - Service Terrestrial Communication Systems, and work under this project will concentrate on frequency - selective influences and bandwidth, flat fade influences and millimetre - wave effects, and site - shielding.

10. Ionospheric Modelling

A recent initiative associated with an aspect of radio propagation has been the development of the new project COST 238; New Prediction Retrospective Ionospheric Modelling Initiative over Europe (Prime). This project will be implemented over the period 1991 to 1995, and has the objectives to develop techniques for using synoptic ionospheric sounding information taken from existing measuring equipments to generate models of the ionosphere needed to estimate propagation effects on telecommunications systems.

11. Array Antennas

COST has implemented projects dealing with the development of array antennas right through its existence. Three projects have already been implemented as follows;

COST 25/1: Aerial Network with Phase Control;
1971 - 1977

COST 204: Phased Array Antennas and their Applications;
1980 - 1984

COST 213: Antennas in the 1990s - Electronically steered Antennas for Future Satellite and Terrestrial Communications:
1984 - 1986

The fourth project in the series currently being implemented is:

COST 223: Antennas in the 1990s - Active Array Antennas for future Satellite and Terrestrial Communications:
Started January 1989, to finish January 1993

The objective of this project is to co-ordinate and advance European research into active array antennas and in particular into new fields of applications. The project programme includes the development, integration and testing of an active array demonstration model operating around 12GHZ, work on active array in the L.S and C bands, and initial development on the next generation of active arrays which will use optical fibre and MMIC techniques.

12. Mobile Radio

The potential for mobile radio in Europe began to become apparent in the early 1980s and COST took an early initiative in this field with the development and implementation during the period 1984 - 1988 of the project COST 207, Digital Land Mobile Radio Communications. The project co-ordinated research activities towards the development of the harmonised pan European digital cellular mobile radio telephone system called the GSM system which is now becoming operational throughout Europe. The project provided inputs for the production of detailed specifications for the system, initially to the CEPT GSM Special Group and later to ETSI.

A follow on project commenced in 1989 which looks at mobile radio in Europe beyond the start of the GSM system. The project, COST 231; Evaluation of Land Mobile Radio (Including Personal) Communications, being implemented during the period 1989 to 1993, has the objectives to develop various elements in relation to the provision and extension of the GSM system, and also to progress development work on a personal or universal land mobile radio system which would come into operation by the late 1990s. It is a large project in terms of the number of participants and currently includes participating entities drawn from 15 COST Countries.

TELECOMMUNICATIONS ACTIVITIES IN EASTERN EUROPE

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1. SITUATION TODAY

The telecommunications networks in some countries in the central part of Europe are to day in the phase that new technology is going to be introduced in the very near future. Some commercial and political boundary conditions have made it difficult to realise plans earlier, making the need for new installations very urgent. Some of this work is also to be realised as a cooperation between the European Community and the country in question.

The telecommunication situation in eastern European countries can be depicted by the following statistical figures (OECD Policy dialogue on Telecommunications Development with Central and Eastern European Countries, Hague 22.24 April 1991) depicting telephone mainlines per 100 inhabitants 1990, (and in brackets growth during 1980-1990 and the annual growth needed in order to reach the OECD level by year 2000)
:

OECD 41.37 (+4.2,+ 0%) , Czechoslovakia 14.26 (+ 3,+10,9%), Hungary 8.64 (+ 4, +16.6%), Poland 8.63 (+5.4, +16.6%).

To take some examples from some countries.

The CSFR enjoyed in telecom earlier an leading position within COMECON . One reason for the low level as compared to the OECD average was the level of tax on telecom revenue, being about 8-10 % in OECD countries and about 37 % in CSFR leaving little available for investment. The short term plans are now digital international centers to Prague and Bratislava, digital trunk network as part of European nets, packet switched data network videotex, paging and message transfer nets. Loans from International Monetary Foundation, World Bank etc. A cellular radio (Bell, US West) and an X25 public packet switched network contract have been signed. Other joint ventures are under way. Philips, Ericsson, Siemens, Motorola could be mentioned as examples.

As late as 1930 Budapest had one of the highest densities of telephones in Europe. During 1960-1970 the situation deteriorated. The number of lines will be raised from 1.2

million lines to 3.4 million before 2000. The basic network as well as the telephone network will remain a Telecom monopoly, the rest of networking can also be managed by (semi-)private companies. A plan today is to have a digital backbone network and to reunite private ministry run networks with public networks.

The new telecommunications legislation (15 January 1991) in Poland is de-monopolising the Polish telecommunications. A new stock company Polish Telecom is created, thus creating the appropriate framework for investment of foreign capital. A contract for an X.25 network (POLPAC) was signed in January 1991, the first four nodes to be installed during this year. New digital international exchanges installed in Warsaw, Katowice and Posnan to follow. Digitalization of trunk going on in collaboration with western partners, today 10% of centers are SPC types (E-10), NMT 450 cellular network for Warsaw is out to tender.Joint ventures with or just big orders from eg. Alcatel-SESA, PZT, Philips, Rosenthal, CIT-Alcatel, Teletran, Siemens, Northern Electric, AT&T, Italtel just to mention some names.

In the Eastern part of Germany with 1.8 million lines some DM 55 billion will create an extra 5.3 million lines before 1997.
The COCOM restrictions on digital systems, microwave systems, CCITT signalling systems etc were mitigated due to the political changes in 1989.

2. COOPERATION WITHIN COST

The situation is thus very favourable for a cooperation within COST. It is well known that the research establishments as well as the telecommunications services providers and the industry have very competent staffs. Many theoretical studies have been produced , which have been used as reference throughout the word. To take an example, it is also very well known that the first x25 type switched networks were implemented in Hungary, although the service later on could not expand as well as it should have done.

The big investments in Eastern Europe can fully be successfully directed if the experts can participate in independent open research cooperation activities like the COST projects. This will ensure that the state of the art and the future trends are taken into account and the procurements really results in a big step towards competitive networking.

BASIS OF COST TELECOMMUNICATIONS COOPERATION ON NETWORKS

Jan Ekberg
Vice chairman of COST TCT
National Agency for Welfare and Health
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1. COST TELECOMMUNICATION PROJECTS

Most COST projects aim to promote basic applied scientific and technical research and are in the nature of pre-competitive research, falling somewhere between fundamental research and development work aimed at defining new products. In a few cases however COST projects have led directly to the development of new products.
The COST telecommunications projects can be regarded as falling into the following main areas:

Telecommunication networks:

- network planning activities,	COST 224
	COST 242
- ultra high speed optical networks,	COST 239
- space/terrestrial networks	COST 226
- -"- -"- mobile networks	COST 227
- simulation of space/terrestrial networks	COST 228

Telecommunications system studies:

- measuring of optical fibres and systems	COST 217
- reliability of optical cables.	COST 218
- optical fibre systems,	COST 234
- characterisation of adv. fibres	COST 241
- modelling of photonic components	COST 240
- mobile radiocommunications,	COST 231
- radio propagation.	COST 235
- ionospheric modelling	COST 238
- multimedia services	COST 237

Telecommunications technology development:

- redundancy reduction for transmission	COST 211
- coding of high definition TV	COST 206
- stereoscopic TV	COST 230
- signal processing	COST 229
- security in communication	COST 225
- new antenna development	COST 223
- electromagnetic compatibility	Proposed project A

Information services and other areas:

- speech recognition in telecom. appl.	COST 232
- synthetic speech in telecom. appl.	COST 233
- human factors	COST 212
- telecommunications for disabled people.	COST 219
	COST 220
- biomedical effects	Proposed project B

A major responsibility of the Technical Committee Telecommunications (TCT) is the identification and development of new COST telecommunications projects. Proposals are made by and through TCT members, the Management Committees of existing projects make proposals, and working parties are set up to develop particular ideas for projects.

The monitoring of the projects is an ongoing task for TCT as well as the evaluation of the results produced.

2. RELATIONSHIP WITH OTHER RESEARCH PROGRAMS AND STANDARDISATION

In the development and implementation of COST telecommunications projects a close relationship is maintained with other relevant European organisations in order to ensure that there is not duplication of effort, and to endeavour to have COST activities complement where appropriate the work of these organisations. A particularly close relationship exists between COST and CEPT, the Organisation of European Post and Telecommunications Administrations, as well as with ETSI the European Telecommunications Standardisation Institute.

There is also a close relationship between COST activities and the programmes of the European Community. In the telecommunications sector (networks), or sectors using telecommunications, the following activities could be mentioned:

EURESCOM

In 1990 a Memorandum of Understanding was signed by the European Public Network Operators for founding a European Institute for Research and Strategic Study in Telecommunication (EURESCOM). The scope of the collaborative work and projects in EURESCOM are:
- The evolution of pan-European services that are offered by the fixed networks.
- A few key areas are included in the initial workprogramme.
- No duplication with work done in RACE , COST or elsewhere.

Items like ATM field trials, Integrated multimedia Services at 1 Mbit/s Broadband research Strategic studies, Coherent multipurpose network Universal Personal communications and Integrated Services management could be mentioned.

RACE II

This programme is building up the technological infrastructure for an integrated broadband network thus including topics like

- Integrated Broadband Communications
- Intelligence in networks
  /flexible communications resource management
- Mobile and personal communications
- Image and data communications
- Integrated services technology
- Information Security technologies
- Advanced communications experiment
- Test infrastructures and interworking

Telematics Systems in Areas of General Interest

This programme includes the following research areas many of which use modern telecommunications networks as a prerequisite:

- Administration (ENS)
- Transport services (DRIVE)
- Health care (AIM)
- Flexible and distant learning (DELTA)
- Rural areas (ORA)

- EUREKA

This programme is based on international industrial cooperation and is active in for instance the following fields:

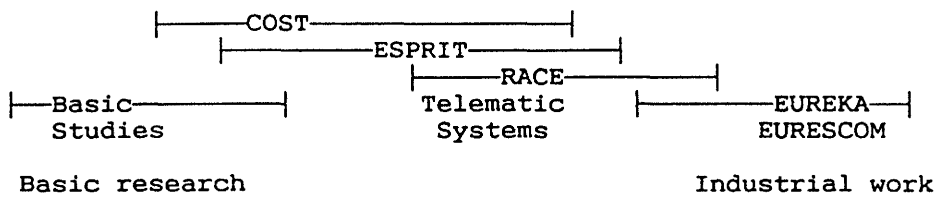
- European research computer network
- Development of imaging systems development
- Secure broadband communications network.

- ESPRIT

The new phase of ESPRIT is not directly working on networks but is active in areas like:

- Microelectronics
- Information processing systems and software
- advanced business and home systems, peripherals
- computer integrated manufacturing and engineering

The relations between these programmes could be depicted by the following picture where go from basic research towards industrial research and standardisation of tested ideas when mowing from left to right.



The diagram also demonstrates that all the different phases are necessary and, to achieve proper industrial results, a gradual development from education to research and from research to industrial fulfillment is needed.
COST plays an important role in this process. Cooperation and not competition is the conclusion that one can draw from the diagram.
A dilemma is caused by the limited resources of people and/or money. On one hand there are the Telecom administrations and industry which in general have funds but limited resources of people; on the other hand there are the research organizations like universities that may have people but usually no money anyway.

3. ROLE OF COST

COST research has a very clear own research area as already shown in the figure above. The pre-competitive way of working and the fact that there is no joint money to fight for, ensures that different scenarios can be studied and information exchanged among the partners. Very often COST work has produced specifications which have after that been used for piloting and industrial implementation within other research organisations, which can offer financial support to well specified and evaluated work. In many cases the original COST team has then also been the kernel in the developments within those research organisations.

COST WORKSHOP TELECOMMUNICATIONS

The Telecommunication workshop was attended by 42 delegates including several delegates from the new Eastern Countries (Czechoslovakia, Hungary and Poland). Unfortunately there were no participants from Iceland but the Icelandic representative in the Senior Officials Committee asked the TCT secretary to keep him informed because Iceland intends to participate in the works of the TCT.

The Workshop Programme is reported below:

Morning Session : 10.00-12.30 Radio Communications

1) Basic paper: J.M. Dwyer : Basic Concepts for Radio Communications in COST

2) W. Riedler: Involvement of Austria in COST Telecommunications
3) M.P.M. Hall: Radiowave Propagation
4)P. Bradley: Ionospheric Modelling
5) E.F. Bolinder: Array Antennas
6) J. Ekberg: Telecommunications Activities in Eastern Europe
7) General Discussion (J.M. Dwyer Co-ordinator)

Afternoon Session: 14.30-1700 Telecommunications Networks

1) Basic paper: J. Ekberg: Basis of COST Telecommunications Cooperation on Networks

2) J. Roberts: Multiservice Network Design
3) O. Koudelka: Integration of Terrestrial and Satellite Networks
4) F. Sporleder: Optical Subscriber Network
5) G. Endersz: Secure Telecommunications
6) General Discussion - Conclusions and Proposed Future Action
(J.M. Dwyer Co-ordinator)

The TCT chairman briefly introduced the workshop explaining the work carried out in twenty years and also illustrated the Telecommunication demonstration which was being held in parallel to the workshop and was started on 21st November when the Ministerial Conference took place. This interesting demonstration contained equipment operating in the fields of High Definition Television (HDTV), Stereoscopic Television and Satellite Communications.

Then the Chairman gave the floor to the various speakers according to the programme.

After both sessions of the Telecommunications Workshop a discussion took place. Several interventions were made, in particular by delegates from the new countries who declared their interest to participate in several projects. Some doubts were dissipated. COST normally makes precompetitive research but it was mentioned that not only the PTTs and different research organizations are involved but there is the participation of industry when required.

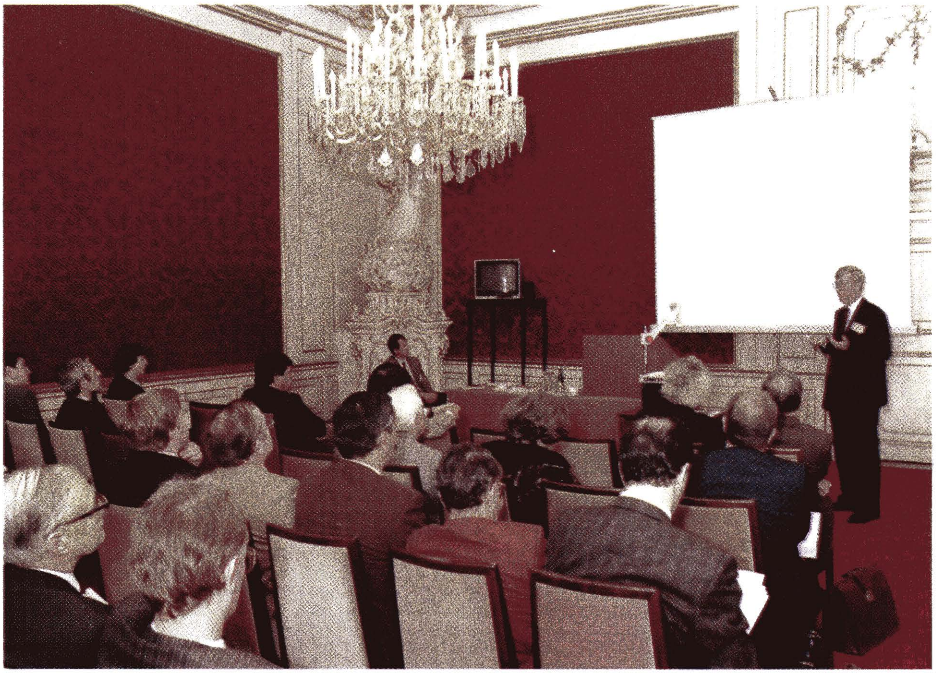
All interested people can obtain more information directly addressing themselves to the TCT secretary in order to receive the last TCT report, to Dr. Ekberg in order to receive the TCT publication including all the news about projects, members of the various projects and all other interesting news (this is the so-called Ekberg Bible) or to the COST Telecommunication office of DG XIII in order to get the general brochures or detailed information about the different projects.

The COST Forum ended with a plenary session where the various chairmen of the Technical (permanent and ad hoc) Committees referred on the development of their workshop.

The TCT chairman recognized that the interest of the telecommunication workshop was particularly effective for the new countries. The major outcome of the workshop is an extended knowledge of what COST can do in the telecommunications research field.

As a result of the workshop the participation of new countries in several projects is expected.

I. TRANSPORT



Workshop "Transport"

OVERVIEW OF COST ACTIVITIES IN THE FIELD OF TRANSPORT

The importance of transport for the COST Member-States, for Europe needs little explanation.

Allow me however a few remarks on transport in relation to COST.

Since long, since 20 years, COST is the only international forum where Member-States debate and initiate transport R&D on equal terms
And these twenty years have not been wasted!
In all modesty COST transport shapes the future.

Cost 306 for example. (automatic transmission of data relating to transport: EDI)
Of course you know that if you want to send a container full of screws from let us say New York to Antwerp, you need another container full of paperdocuments.
(If you stretch out the documents they have a length of ten meters, not taking into account the copies)
COST 306 developed the first standards to be accepted worldwide for electronic transport messages; and it proved its functionality through a pilot to which firms of fourteen European countries participated.

This morning at our workshop, we shall look into the aspects of EDI related to east - west transport flows, as these are at the core of succesful development of economic relations.

Another example:
Several organizations recently took up the subject of Road Transport Informatics (RTI) nowadays also called Advanced Transport Telematics (ATT).
You are surely aware that COST, 10 years ago, demonstrated already the first generation of such applications.

Also in the maritime sector I can say that COST pioneered and delivered a fundamental study on Vessel Taffic Services. This study forms still the basis for most of the maritime R&D related to pollution control and safety.

I do not believe therefore that I have to convince you that COST Transport is where the future is made today.
With your support, with the support of all 23 Member States, I'm sure that COST Transport solves also the remaining problems in the transport field like there are
congestion
risks of transport of dangerous goods
...

TRANSPORT WORKSHOP 22 November 1991

HALF-DAY DISCUSSION ON EDI

10:45 AN OVERVIEW Tony Davies

Concluding Remarks

- The rapid growth and increased stability of UN/EDIFACT Standard EDI messages now offers the possibility of catering for a wide range of business functionalities across a broad spectrum of industry sectors. The adoption of generic principles also offers the added opportunity for the implementation of EDI in a multi-sectorial environment.

- Sectorial growth in UN/EDIFACT development activities is expanding but is not matched by geographic growth which is limited to Western Europe, North America, Far East and Australasia but not Eastern Europe.

- Transport and trade related messages are under active development but logistics management has not yet been fully considered. This needs urgent consideration due to the imminent commencement of the Single Market within the EEC and the closer trading links with Eastern Europe.

- Telecommunication service levels vary across Europe which may impede the growth of EDI. The reluctance of the Value Added Networks to introduce interconnectivity for inter-VAN communications is also recognised as an obstacle to EDI growth. The promotion of a truly open systems environment using X400 Message Protocol and the possibility of using UN/EDIFACT messages to achieve inter-VAN connectivity needs to be vigorously encouraged.

- The level of EDI awareness amongst the small to medium sized enterprises is generally poor. The cost of employing consultants within this sector is prohibitive, therefore Centres of Information should be created and made accessible to all SMEs to encourage EDI implementation.

Transport Workshop

Vienna, 22 November 1991

Henk van Maaren

Key point of presentation

- EDI in transport has become an accepted feature in Western Europe certainly for the larger companies and for most of the medium-sized companies. This does not mean that they all practice EDI already, but that at least they are seriously contemplating the subject. Some sectors within transport are quite advanced, some others are in the beginning of development. But the road is long and it will take some decades before EDI has really replaced paper documents.

- In Eastern Euope EDI is in its infancy. It will be necessary to increase both the present limited number of experts as well as their level of competence.

- EDI can only be implemented if the basic technical tools are available, especially with respect to telecommunication facilities and EDI-software, first steps have been taken in Eastern Europe for this.

- To fully understand and appreciate EDI and its potential impact, practical experience is essential. Some pilots involving Eastern European organisations should be a priority issue.

- EDI can play a useful role in improving the process of the movement of goods. For international movements related to Western and Eastern European trade this would be beneficial to all parties. It will be necessary however to obtain a better understanding of the procedures and documents involved in the trade between West and East Europe.

- COST has proven to be a good platform for important EDI activities, such as the original EDIFACT transport message development, international EDI trials, etc., COST could also provide a good platform for joint EDI activities of countries from West and East Europe.

ERIK TOFT

IMPROVEMENT OF URBAN TRANSPORT: SYSTEMS OF LIGHTLY GUIDED PUBLIC TRANSPORT SYSTEMS - VIENNA 22 NOVEMBER 1991.

The economic, demographic and educational developments together with the land-use pattern in major urban conurbations in Europe in the last 20-30 years have led to a dramatic increase in the demand for and use of private cars. The increased leisure time and the endeavour for flexibility, identity and self-control have resulted in a more intensive car use for a still growing number of people.

In the same period public transport has, as an overall tendency, not been able to live up to peoples aspirations and demand for service. As a consequence the economic results of the public transport companies have as a general rule deteoriated, which again has made it more difficult to improve the service leading to a fall in market share and thereby started a negative downturn for the public transport system.

The negative effects of these developments have been experienced to a varying extent in every bigger city in Europe. Traffic congestion and traffic jam are an everyday phenomenon leading to a loss of time and welfare for millions of people, not forgetting that the major number of traffic casualties is occuring in densely built-up areas.

In addition to the effects on users of the roadbased traffic system, the growth in car traffic has also put a tremendous pressure on the urban environment in general. Mainly transport is responsible for the urban air- and noise pollution; roads and parking places seize major parts of urban space.

There is widesprad consensus that transport and travelling conditions will soon become so poor as to hamper the economic and social developments of major cities. This is already the case, but the drawbacks have yet to cancel the benefits of agglomeration.

It is evident that a shift from private to public transport would alleviate some of the urban transport and related problems. It is a challenge to realise this shift.

To work out solutions there has been an increasing interest in "new" mass transit systems especially light rail or pre-metro systems. A lot of these systems have been implemented not only in Europe but also in the US. And many other cities consider to introduce these new systems or modernise their existent tramways.

This development and increasing interest raises some questions of general concern.

Firstly: What is the potential of the different systems on the market and after what criterions are a public transport authority to choose? Which limitations does the existing public transport system put on the possibilities of choice? And especially, is it possible to make some generalisations on European level based on the experiences of public transport companies so far?

Secondly: One of the goals of the community is to secure free competition between the transport operators and thereby increasing the efficiency. When it comes to choosing a system, every city seems to go for itself judged from the overview of the existing systems and from the brochures issued by the public transport authority.

There are diffences in traction, in control systems, in track gauge, width, height, floorheight etc.

One of the problems in a situation like this is that the technical differences will become technical barriers, and thus remove one of the necessary conditions for securing competition between transport companies bidding for the permission to operate the service.

The tacit assumption behind this problem identification being that you should have a separation between operation of the service and management of the infrastructure also at rail guided public transport systems in cities. Which of course also is open for discussion.

Another problem is that there is a risk of not being able to realise economies of scale in manufacturing equipment for urban (light) rail systems and to limit competition, or in the extreme create a monopoly suppplier, in a situation where the existing system is going to be expanded.

The goal of this workshop is to identify research and development tasks in the area of urban mass transit systems which could be relevant to develop on a European scale.

COST workshop Transport
Vienna 91 11 22

The workshop dealt with two different issues:
Electronic Data Interchange and Light Rail Systyms.

These topics had been chosen as they were considered to be promising for R&D now that four states had joined the COST-organization.
The discussions during the workshop were meant as a first exploration of actual opportunities.
This has been achieved.
The follow-up should be prepared in close cooperation between the Member States.

EDI

EDI was chosen for the following reasons:
EDI is in many respects crucial for the performance of transport and distribution services as it creates the prerequisites for better control and management of these services;
EDI is a subject that is very familiar to COST. COST developed the basics for the first standards to be accepted worldwide for transport messages and proved its functionality through a pilot-exercise. (COST 306).
COST is also engaged in an European wide research on the effects of EDI-implementation on the transportsector (COST 320);
In the new COST Member States there exists excellent theoretical knowledge of EDI, be it that this knowledge is not widespread through the whole transport sector, but there is a clear lack of practical experience;

The workshop developed these themes.
Furthermore, the participants recognized that the trade relations between east and west Europe would be greatly enhanced by succesfull implementation of EDI in the transport and distribution sectors.
With the rapid growth and increased stability of UN/EDIFACT standard EDI messages there is enough encouragement to all parties in transport to use EDI instead of countless and diverse documents.
A first suggestion was made how COST could contribute to increase awareness and practical experience of EDI in the east-west context.

Light Rail Systems in mass urban transport

This topic was chosen given:
the growth of light rail systems;
the diversity of these systems, in particular in the western states;
the growing importance and also need for the use of public transport;
the fact that in the new COST Member States from East Europe public transport takes a predominant place in mass transport.

The discussion on the LRS could not be isolated from the general public transport policies and operations in the European cities.
It became clear that technical R&D concerning public transportmodes is not lacking. Yet scientific R&D as to the question which mode of public transport is most suitable under certain conditions has hardly been executed. In particular one can think of the relationship between mobility patterns within cities, including in- and outgoing movements, and the available public transport alternatives.
Also there is a lack of analysis and comparative evaluation of the interaction of the various public transport systems.
Totally unclear is also the advantage or disadvantage of the different operational mechanisms in public transport, especially the monopoly position of the providers.
Research on these questions and their results could be effectively used as instrument by policymakers in deciding on public transport systems and operations.

Finally it was suggested to look into technical harmonization aspects of the vaious systems. This could not only lead to a more users friendly public transport, it will certainly have economic benefits for the producers and the buyers (the cities).

J. FORESTRY & FORESTRY

Workshop "Forestry and Forestry Products"

Ad hoc Committee "Forestry & Forest Products"

COST-FORUM Vienna, 22.11.1991 plenary session: Overview of COST research activities in the field of "Forestry and Forest Products"

Besides two running COST actions, COST 508 on "Wood Mechanics" with special emphasis on the rheological properties of wood and wood based materials and COST 813 "Diseases and Disorders in Forestry Nurseries" dealing with pathologic problems encountered in forest nurseries, the ad hoc Technical Committee on "Forestry and Forest Products" was set up in 1990. This Committee has to identify on a comparative basis the research and development needs which exist in the relevant area and evaluate the topics on which efforts should be concentrated at European level and for which special COST activities should be undertaken. As a first step for reaching the goal of identifying the research areas of common interest, the COST Technical Committee on "Forestry and Forest Products" carried out an inventory of the existing research activities. For this purpose the area of forestry and forest products has been divided into three sectors: 1. Forestry research, 2. Wood and wood products research, 3. Pulp and Paper as well as wood chemicals research. For each sector a list of research themes has been elaborated. Together with these lists, a questionnaire has been sent out to all relevant research units asking for research themes under study and also asking for information per theme on: the number of research personnel, divided into:

- "scientists" (defined as research personnel having an academic degree") and
- "technical research personnel" (defined as 'everyone else who contributes to the research project in a technical aspect' such as technicians, technical assistants as well as graduate or scientific students).
- the annual budget,
- existing European cooperation, and
- priority given to the research project by the research unit, using the scale: '1' of very high priority, '2' of high importance, '3' of importance, '4' of little importance and '5' of no importance.

The answers to this questionnaire about the research capacities in the three sectors of forestry and forest products research are presently still under evaluation. Detailed information of the results of this study will be given in the interim report. Together with the requested national opinions on research priorities in the relevant sectors these results will give a good basis for further discussions and decisions of the COST ad hoc Technical Committee on "Forestry and Forest Products" about research areas of common interest and further activities of the Committee. The other objective of this Committee is to establish national research priorities within the areas forestry, wood technology and pulp and paper (including chemicals from wood). The 17 participating countries have been invited to identify a maximum of 10 topics within each area. The aim is to identify similarities and differences in view among the participating countries. This material shall also form a basis when later, the committee is to define areas of future research, within the European context, which are of broad, mutual interest.

J.F. LACAZE
Chariman

Research areas of common interest for COST-members to be developed at European level in the field of forestry and forest industrial research

Lennart Eriksson (STFI, Swedish Pulp & Paper Research Institute, Stockholm)
Detlef Noack (Federal Research Centre for Forestry & Forest Products, Hamburg)
José Pardos (ETS Ingenieros Montes, Universidad Politecnica de Madrid)

Forestry and forest products form an integral part of society and of the daily life of its members. The forest is a renewable resource. When growing, it binds carbon dioxide from the atmosphere and at the same time produces a raw material with a tremendous span of applications from energy over construction materials to chemicals and paper products. The forest is also a site for recreation and for animals and plants. It is a working place for many people.

Forest products are environment and consumer friendly. They are degradable in nature, can be burnt for energy production without adding to the carbon dioxide problem or recirculated for the production of new products. In this sense forest products must be regarded as almost ideal materials.

Forestry and the production of forest products is on a long term basis intimately connected to the environment. A good environment is a prerequisite for healthy and productive forests. The production of forest products no doubt causes emissions and other residues that might have negative effects on the environment if not handled properly. Over the last decades a tremendous progress has, however, been made in lowering emissions to air and water and intensive work is ongoing in order to achieve further reductions. The goal is a production technology with no short or long term effects on the environment.

The production of forest products requires large amounts of energy - especially the pulp production. This is still true despite large efforts to develop more energy efficient processes. However, a modern mill making paper out of chemical pulp is today essentially self sufficient in energy. This is achieved through the burning of spent cooking liquors.

The possibility to increase the use of waste paper (recycled fibres) is today an important issue with many implications. For an extended recycling to be efficient - considering all aspects of the problem, viz. environment, energy, product quality, product safety and economy - it is important that the burning of some parts of the wastepaper is recognized as a natural part of the cycle.

The quality demands on forest products is continuously increasing, coupled to higher and higher production rates (volumes per time unit, speeds etc). This is not always an increase towards what by some could be classified as "luxury" products or products with an unnecessary finish. It is more a question of uniformity (in space and time). It is a question of maintaining important product properties over time, and, above all, it is a matter of satisfying the demands of the user - be it a converter (e.g. a printer) or the end consumer.

All these demands put together and coupled with a projected increase in world wide demand form an enormous challenge to forestry and forest product industries. To meet this challenge, long term R&D is a key factor.

Forestry and the production of forest products cover an enormous span of research fields and competencies. It is hard to find a field of scientific expertise that would not find its application in this area. R&D is needed at all levels from long term research to mill testing of new concepts, and at all degrees of sophistication.

The work of the COST and the ad hoc technical committee "Forest and Forest Products" should be viewed against the above background. The committee started its work in the fall of 1990. According to its terms of reference, the committee shall after two years of work be prepared to suggest research areas suitable for further COST actions. As a first stage, it was decided to carry out two studies, which are still ongoing. The first was to carry out an inventory of the existing research resources within universities and other non-company research institutes, including the number of the academic researchers, technicians and research students as well as research directions of these organizations. A progress report of this inventory will be given as part of the COST forum (see abstract by Professor D. Noack).

The other study involves an effort to establish national research priorities within the areas forestry, wood technology and pulp and paper (including chemicals from wood). The 17 participating countries have been invited to identify a maximum of 10 topics within each area and these topics should preferably be chosen from given lists. (See Appendixes B, C, D to the abstract by Professor Noack).

The object of this study is to identify similarities and differences in view among the participating countries. This material shall also form a basis when later, the committee is to define areas of future research, within the European context, which are of broad, mutual interest.

This study is presently not completed. It has turned out to be a time consuming process to define what can be regarded as "national priorities". It is, for example, not self evident what interest groups should participate in such a process.

At the COST forum, the intention is to discuss the results obtained so far in this study of national priorities.

Research activities in the EC countries in the field of forestry and forest industrial research

Lennart Eriksson (STFI, Swedish Pulp & Paper Research Institute, Stockholm)
Detlef Noack (Federal Research Centre for Forestry & Forest Products, Hamburg)
José Pardos (ETS Ingenieros Montes, Universidad Politecnica de Madrid)

The COST ad hoc Technical Committee on "Forestry and Forest Products" has been set up in 1990 in order to identify on a comparative basis the research and development needs which exist in the relevant area and to evaluate the topics on which efforts should be concentrated at European level and for which special COST activities should be undertaken. In this respect it may be mentioned that one COST action in the field of timber and forest products has already been installed in the past, this is COST Programme 508 on "Wood Mechanics" with special emphasis on the rheological properties of wood and wood based materials.

As a first step for reaching the goal of identifying the research areas of common interest, the COST Technical Committee on "Forestry and Forest Products" carried out an inventory of the existing research activities. For this purpose the area of forestry and forest products has been divided into three sectors:

- Forestry research

- Wood and wood products research, and

- Pulp and Paper as well as wood chemicals research.

For each sector a list of research themes has been elaborated which are represented in Appendixes B, C and D. Together with these lists, a questionnaire (Appendix A) has been sent out to all relevant research units asking for research themes being under study according to the Appendixes B, C, and D and also for each such theme asking for information on:

- the number of research personnel, divided into

  "scientists" (defined as research personnel having an academic degree") and

  "technical research personnel" (defined as 'everyone else who contributes to the research project in a technical aspect' such as technicians, technical assistants as well as graduate or scientific students).

- the annual budget,

- existing European cooperation, and

- priority given to the research project by the research unit, using the scale: '1' of very high priority, '2' of high importance, '3' of importance, '4' of little importance and '5' of no importance.

The answers to this questionnaire about the research capacities in the three sectors of forestry and forest products research are presently still under evaluation. Therefore, results can not be presented as a preprint. However, detailed information of the results of this study will be given at the Vienna Meeting. Together with the requested National opinions on research priorities in the relevant sectors these results will give a good basis for further discussions and decisions of the COST ad hoc Technical Committee on "Forestry and Forest Products" about research areas of common interest and further activities of the Committee.

<u>Enclosure</u>: Appendixes A,B,C, and D.

Appendix A

Questionnaire

about European Research in

Forestry,

Wood and Wood Products, and

Pulp and Paper as well as Wood Chemicals

Institution (1): ....

Main themes	Number of personnel scientists	technical personnel	Annual budget	Existing European Cooperation	Priority	Comments
(2)	(3a)	(3b)	(4)	(5)	(6)	(7)

(1) Name, address, telefon, telefax

(2) Use if possible the relevant list of Appendices B, C or D.

If a particular theme is irrelevant for your country, leave blank. Feel free to add to list or change wording. This inventory covers precompetitive research, not development work.

(3) Equivalent full time per year (average over 2 years).

(4) Not compulsory: mean annual budget during the last 3 years.

(5) If yes, identify this cooperation: name of cooperating institutions and/or your suggestions regarding possibility and willingness of European cooperation in the frame of the COST-Programme.

(6) Indicate priority according to scale: 1 - of very high priority (this means a project of increasing work in the near future), 2 - of high importance, 3 - of importance, 4 - of little importance, 5 - of no importance. This concerns the priority at the institution level. National priorities will be examined later.

Appendix B

List of themes of the "Forestry Research"

1 Forest systems: structure, dynamics and performance

2 Site: ecological characterization

3 Forest hydrology; watershed management and restauration; Torrents, mud flows and snow damage

4 Fires: prevention, effects and control; Reconstruction of fired lands

5 Anatomy, biochemistry, biogeochemistry, biogeophysics, floras, taxonomy, geobotany, paleophytogeography

6 Tree physiology: ecophysiology, nutrition, development, reproduction, plant propagation

7 Genetics and breeding; variation and evolution; choice of species; proviences; conservation of genetic resources; biotechnology; wood and cork genetic improvement

8 Mycology and pathology; resistance to diseases

9 Insects and other invertebrates; pest protection and control

10 Air pollution and climatic changes: effects and control; effects of sludge and other organic materials in forests

11 Reforestation: plant material, nurseries management and stands establishment operations

12 Interactions soil/species, sylviculture and environment conditions

13 Sylvicultural treatments of natural stands and plantations

14 Agroforestry

15 Reconversion and abandoned farming land to forest and cattle-raising uses

16 Nature conservation and management of protected areas; National parks

17 Fast growing species: management and productivity

18 Forest operations: harvesting, long distance transport etc.; social aspects of labour

19 Wildlife: habitats and management

20 Game management

21 Aquiculture: biology, control and yield of continental waters

22 Land use: forest management planning and managerial economics

23 Landscaping; arboriculture; recreation; social and historic aspects of forestry

24 Economic aspects of forestry; forest policy, law and administration; linkages between forestry and forest industry; long-term estimation of potential cut; work analyses and ergonomics

25 Mensuration, growth and stand models and yield

26 Data capture and processing: teledetection, statistical methods, computers; forest inventory

27 Information systems and terminology

28 Management, evaluation and applying results of forest research

29 Forest energy

30 Dendrochronology, dendroclimatology, dendroecology

31 Environmental impacts; environmental effects of forestry

32 Tropical forestry

33 Other products than wood and game: cork, resin and other secretions, fruits, mushrooms, lichens, Christmas trees

Appendix C

List of themes of the "Wood and Wood Products Research"

1 Economical studies

- 1.1 Analysis of national and international markets
- 1.2 Influence of forest decline and other forest calamities on roundwood market
- 1.3 Economical studies related to processing of wood and wood products

2 Quality of wood and wood products

- 2.1 Determination of wood quality of roundwood
- 2.2 Avoidance of quality reduction during wood storage
- 2.3 Influence of sylvicultural practices on wood properties
- 2.4 Influence of forest decline and other calamities (e.g. forest fires) on wood properties
- 2.5 Determination of the properties of wood and wood products which are relevant to wood processing:
  - 2.5.1 - Particle producing machining of wood
  - 2.5.2 - Non-particle producing wood processing
  - 2.5.3 - Special treatments of wood processing
- 2.6 Determination of the properties of wood and wood products which are relevant to the end-use:
  - 2.6.1 - Surface properties
  - 2.6.2 - Strength properties, rheological properties
  - 2.6.3 - Dimensional stability
  - 2.6.4 - Physical properties (building physics)
  - 2.6.5 - Natural durability
- 2.7 Application of non-destructive test methods for grading and quality control of:
  - 2.7.1 - Sawn timber
  - 2.7.2 - Veneers
  - 2.7.3 - Wood based panels
  - 2.7.4 - Other wood products

3 Improvement of the quality of wood and wood products

- 3.1 Improvement by treatments
  - 3.1.1 - Steaming and drying
  - 3.1.2 - Surface treatment
  - 3.1.3 - Impregnation treatments
  - 3.1.4 - Environmental safer wood preservation
  - 3.1.5 - Wood preservation against fire
- 3.2 Improvement by gluing
- 3.3 Improvement of wood structural elements
  - 3.3.1 - Solid wood
  - 3.3.2 - Laminated beams
  - 3.3.3 - Sandwich constructions
  - 3.3.4 - Mechanical connections
- 3.4 Reduction of environmental detrimental properties

4 Improvement in wood processing

- 4.1 Drying
  - 4.1.1 - Drying of sawnwood
  - 4.1.2 - Veneer Drying
  - 4.1.3 - Drying of wood particles and fibres
- 4.2 Increase of the yield of raw material
- 4.3 Utilization of low-grade and small-sized wood
- 4.4 Utilization of wood residues
- 4.5 Recycling of used and treated wood material
- 4.6 Wood preservation processes
- 4.7 Process control systems
- 4.8 Reduction of environmentally critical emissions during production
- 4.9 Sawmilling
- 4.10 Glumlam
- 4.11 Processing of wood based products
  - 4.11.1 - Veneer
  - 4.11.2 - Longitudinal veneer laminates, plywood
  - 4.11.3 - Particle board
  - 4.11.4 - Fibre board
  - 4.11.5 - Mineral-bonded wood based panels
  - 4.11.6 - Composites
  - 4.11.7 - Other panel products

5 Improvement in the manufacture and design of wood products

- 5.1 Bended wood, moulded parts
- 5.2 Wood products, such as windows, doors, parquet, pallets, packaging
- 5.3 Floor, roof, and wall constructions
- 5.4 Prefabricated houses
- 5.5 Furniture
- 5.6 Other wood products

6 Studies on timber engineering and wood constructions

- 6.1 Mechanics of innovative constructions
- 6.2 Long-time strength and deformation behavior
- 6.3 Investigations about safety problems

7 Establishment of relevant quality and performance Standards

8 Wood and wood residues as raw material for energy production

Appendix D

List of themes of the "Pulp and Paper as well as Wood Chemicals Research"

1 Fibrous raw material

- 1.1 Logistics
- 1.2 Cleaning (incl. barking)
- 1.3 Chipping
- 1.4 Morphology, chemical composition
- 1.5 Deinking
- 1.6 Waste fibre upgrading

2 Pulp production

- 2.1 Chemical pulping, improved processes
- 2.2 Chemical pulping, new processes
- 2.3 Mechanical pulping
- 2.4 Bleaching, improved processes
- 2.5 Non chlorine bleaching
- 2.6 Chemicals recovery
- 2.7 Wood chemistry
- 2.8 Fibre and pulp characterization

3 Paper production

- 3.1 Stock preparation
- 3.2 Sheet forming (incl. flocculation, retention)
- 3.3 Dewatering and consolidation
- 3.4 Fibre properties and sheet properties
- 3.5 Sheet characterization
- 3.6 Fillers and pigments
- 3.7 Chemical additives

4 Paper finishing

- 4.1 Calendering
- 4.2 Coating
- 4.3 Surface treatment
- 4.4 Composites

5 "Products and society"

- 5.1 Recyclability
- 5.2 Chemical composition
- 5.3 End-user aspects
- 5.4 Durability (ageing) of paper

6 Effluents and environmental effects

- 6.1 Effluent characterization
- 6.2 Effluent treatment, air
- 6.3 Effluent treatment, water
- 6.4 Sludgehandling

7 Energy conservation

- 7.1 Reduced power consumption
- 7.2 in mechanical pulping
- 7.3 in refining
- 7.4 in paper production
- 7.5 in general
- 7.6 Reduced heat consumption
- 7.7 In-mill power generation
- 7.8 In-mill heat generation

8 Control technology

- 8.1 Sensor development
- 8.2 Process models
- 8.3 Tools for process analysis
- 8.4 Process control systems
- 8.5 Mill-wide control
- 8.6 "Expert systems"

9 Chemicals from wood

Ad hoc Committee "Forestry and Forest Products"

COST-Forum Vienna, 22.11.1991

WORKSHOP

The work group Forestry and Forest Products have successively heard the following reports:

- Presentations by Messrs. Eriksson (Sweden), Lacaze (France), Noack (Germany) and Pardos (Spain), regarding the activities of the ad hoc Committee on Forestry and Forest Products. The emphasis was placed on results obtained :

    - the inventory of European research means in the field of forestry, wood materials and pulp and paper.

    - the inventory of research priorities in these fields for the years ahead.

- Presentation of the general situation for forestry, wood industries, pulp and paper in three Eastern countries (Hungary, Czechoslovakia, Poland), as well as the evolution of research policy in these sectors.

Following a wide exchange of views, the three countries in question expressed their strong desire to participate in the work of the ad hoc Committee on Forestry and Forest Products.

In view of the historical course of political and economic changes taking place in the Eastern European region, the general need was recognised to be the reinforcement of technical and scientific relationships and the building up of a network system with the EC countries. The main strategic objectives in the field of S&T for Poland, Hungary and Czechoslovakia are the modernisation, increase in productivity, the specialisation and consideration of environmental problems.

They were most interested in the activity of the ad hoc Technical Committee. Their integration into this group could enable an extension of the survey and the definition of R&D priorities for their countries.

J.F. LACAZE
Chairman

K. ENVIRONMENT

Workshop "Environment"

COST FORUM, 22/11/1991 VIENNA

ENVIRONMENT

Overview of COST activities in the field of Environment

Within the EC Environment Research Programme, the following Concerted Actions have been implemented:

COST 611	*Physico-Chemical Behaviour of Atmospheric Pollutants*
COST 612	*Air Pollution Effects on Terrestrial and Aquatic Ecosystems*
COST 613/1	*Indoor Air Quality and its Impact on Man*
COST 613/2	*Epidemiological Investigation of the Effects of Atmospheric Pollution on Human Health*
COST 641	*Organic Micropollutants in the Aquatic Environment*
COST 647	*Benthic Coastal Ecosystems*
COST 681	*Treatment and Use of Organic Sludges and Liquid Agricultural Wastes.*

Some of these started in 1972, their objectives and scientific content, however, have been extended and reviewed extensively.

The principal activities within these Concerted Actions were the coordination of research funded at national level, organization of workshops and Symposia, dissemination of research results in view of the identification of gaps of knowledge and recommendation for further research to be implemented.

All those formally ended in 1990, but arrangements have to be found to continue and also to start modest cooperation with countries from Eastern Europe.

To this end, it is hoped that the Workshop on Environment, in addition to a presentation of the main achievements, permitted to exchange ideas and to explore the potential of competence and interest among Eastern scientists.

Atmospheric Pollution by Photooxidants over Europe

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1. Introduction

In the beginning of the COST 611-Action in 1973 the chemical behaviour of atmospheric SO_2 oxidation leading to H_2SO_4 and sulfates was the major objective of the coordinated European research programme. At a later stage the whole range of oxidation processes covering the gaseous and aqueous phase as well as solid surfaces was added to the programme under the title "Physical-Chemical Behaviour of Atmospheric Pollutants". It is interesting to note that the gaseous phase oxidation of SO_2 in the presence of NO_x is able to form ozone; these findings have been reached in the US as well as within the COST 611-Action. Other COST 611 results showed that the aqueous phase oxidation of SO_2 is significantly accelerated by the photooxidant species O_3 and H_2O_2 dissolved in the water droplets, pointing to the link between photooxidants formed in the gaseous phase and the oxidation processes in rain and fog droplets. Only recently it has become possible to measure atmospheric H_2O_2 concentrations at several sites in Europe whereas O_3 has been measured for many years, although not always by appropriate techniques. Many data on diurnal O_3 concentrations and O_3 altitude profiles were presented at the several working party meetings of COST 611 (Lit. 1) and the Technical Symposia (Lit. 2) which were held every two years in Italy. In addition, review articles about European O_3 measurements are available. Presently the measurements of all important photooxidant species and their precursor compounds are being carried out within the EUROTRAC/TOR subproject. Laboratory work on the photooxidant chemistry is being carried out by the two EUROTRAC subprojects LACTOZ and HALIPP which are jointly coordinated with COST 611 (Lit. 3).

Photooxidant formation which is characterized by ozone as indicator component is observed during summer time in all urban areas. In Western Europe a peak level above 100 ppb seems to be considered as a level above which health effects cannot be excluded completely; levels above 200 ppb can cause series effects. Damage to plants has been reported for O_3 values even below 100 ppb (1 ppb = 1 : 1 000 000 000 volume mixing ratio).

In air masses which contain volatile organic compounds (VOC) and nitrogen oxides (NO_x: NO and NO_2) so called "photooxidants" are formed by sunlight with ozone (O_3) acting as the leading component.

2. Tropospheric Photooxidants

without nitrogen oxides (NO_x):

- hydrogen peroxide (H_2O_2) and organic hydroperoxides (ROOH)
- organic acids (RCOOH)
- aldehydes (RCHO) and ketones (RCR'O)
- alcohols (ROH) and organic acids R(O)OH
  (R: organic group)

with nitrogen oxides (NO_x):

- ozone (O_3)
- peroxyacetyl nitrate (PAN: $CH_3C(O)O_2NO_2$) and other peroxynitrates (RO_2NO_2)
- organic nitrates ($RONO_2$)
- nitric acid (HNO_3)

3. Ozone Chemistry

In the upper stratosphere atmospheric oxygen is photodissociated by sunlight at wavelengths below 200 nm. The resulting oxygen atoms recombine with molecular oxygen to form ozone. This process results in the formation of the ozone layer which protects the Earth's surface from short wavelength radiation. Light with $\lambda < 300$ nm cannot pass through the stratosphere to the Earth's surface. At the limit of 300 nm (UV-B) the transmission depends critically on the ozone total-column-height betweeen the ground and the sun. Reductions of the column height, which are regulated almost entirely by the stratospheric ozone concentration, lead to an increase of sunlight intensity in the UV-B at 300 nm at the Earth's surface. An important atmospheric chemical process at this wavelength is the photolysis of ozone:

$$O_3 + h\nu \rightarrow O('D) + O_2\,('\Delta_g),\ \lambda \leq 310\ \text{nm}$$

which in the presence of water vapour results in the formation of OH radicals:

$O('D) + H_2O \rightarrow 2\ OH$

In summer during midday the OH formation rate at middle latitudes is ~ 0.6 ppb/h with 50 ppb ozone and 70 % relative humidity. As will be discussed below this pathway for OH radical generation is of critical importance for the formation of photoxidants in photosmog due to the oxidation of VOC in the presence of NO_x. Recently formation of OH in the atmosphere by O_3 photolysis has been confirmed by field measurements at a rural site in Germany, however, the measured OH concentrations are significantly lower than those predicted by model calculations (Lit. 1, 4).

A small proportion of tropospheric ozone ($\leq$ 20 %) comes from the stratosphere. Contrary to earlier beliefs most of the ozone in the troposphere is produced by photochemical processes within the troposphere.

Tropospheric Ozone Sources

- transport from the stratosphere (19%)
- photochemical processes in the trophosphere (81 %)

Tropospheric Ozone Sinks

- photolysis of ozone at 300 nm / $O(^1D) + H_2O$ (34 %)
- deposition to the ground (21 %)
- reaction with OH/HO_2, NO and alkenes (45 %) (Lit. 5)

4. Field Measurements

At the beginning of the seventies measurements in the Netherlands, England and also Germany had shown that air masses containing nitrogen oxides and reactive organic gases can result in the formation of high ozone peak concentrations in urban areas. This phenomenon can only be satifactorily explained by photochemical processes occuring in the lower air layers. For example the follwing 1/2 or 1 hourly peak values were observed in Europe as shown in table (1).

Table (I): Peak concentrations of ozone near the ground at different European sites (1/2 or 1 h values)

City	Year	$[O_3]$ peak (ppb)	Remarks
Mannheim (D)	1976	332	
Cologne (D)	1981	273	
Vlaadingen (NL)	1976	270	
Harwell (UK)	1976	258	
Athens (GR)	1982	> 250	for a period of > 5h
Paris (F)	1976	215	
Ilmitz (A):	1979	200	for a period of > 14 h
Oslo Fjord (N)	1979	199	
Rome (I)	1974	140	
Zagreb (YU)	1977	140	
Rorvik (S)	1979	> 100	

(Lit.. 6) [ ]: Concentration as volume mixing ratio

At the VDI-Colloquium (Lit. 7) entitled "Ozon und Begleitsubstanzen im photochemischen Smog" which was held in 1976 in Düsseldorf the occurrence of "summer smog" in Germany and some Western European countries was convincingly demonstrated and the physico-chemical reasons for its formation presented. Since then, in particular also by the CEC/COST 611-Action further detailed information has emerged and it is now possible to provide a significantly better quantitative description of the chemical system producing the photooxidants. What is still missing is an exact knowledge of the precursor emissions of NO_x and of VOC in order of importance of the various components. Further, it is still open to debate not only what kind of ozone averaged value is best for describing the photooxidants formed during the daytime but also what time average of $[O_3]$ is most suited for an estimation of the effect on people and plants. Presently, the main interest is focussed on the 1/2 or 1 h-ozone peak concentrations which are very sensitive to the $[VOC]/[NO_x]$ mixing ratio near the major emission sources. It should be noted that in the free troposhere above the planetary boundary layer the ozone yearly mean value in West Europe lies between 40-45 ppb. This ozone background concentration is also largely governed by the chemical processes occurring in the troposphere. There is evidence that the ozone background concentration in the free troposphere and also within the boundary layer has significantly increased over the last 100 years due to the increase of CH_4, CO and, in particular, NO_x emissions (Lit. 8,9).

It has been known for some considerable time from laboratory experiments that the irradiation of air + VOC + NO_x mixtures leads to ozone formation and that VOC and NO_x are necessary precursors for the formation processes. The experiments show also that by a constand VOC concentration with increasing additions of NO_x the O_3 maximum concentration which builds-up in the photochemical system increases and above a NO_x-limit suddenly decreases. This sudden decrease is mainly due to the reaction $NO_2 + OH \rightarrow HNO_3$ which at high NO_x concentrations can compete effectively with the primary oxidation step VOC + OH. In an excess of VOC over NO_x the maximum O_3 concentration also decreases but not as rapidly as in the reverse case. Systematic smog chamber experiments have lead to the generation of O_3 isopleths. Based on these isopleths the US adapted the strategy that depending on the [VOC]/[NO_x] mixing ratio during the early morning period 6-9 h the VOC emission had to be reduced so that a 1 h average maximum value of 120 ppb should at the most exceeded only once per year. This EKMA-strategy of the US-EPA is currently being critically assessed because of the complexity of the VOC mixtures and also the large proportion of biogenic VOC emissions which are also involved in oxidant formation. However, based on the EKMA approach and empirical findings in Los Angeles the following estimates are still valid:

[VOC]/[NO_x] (in ppbC/ppb) > 10: between 6 and 9 h; NO_x reduction decreases the O_3 peak concentration around midday in the urban centres.

[VOC]/[NO_x] (in ppbC/ppb) < 10: between 6 and 9 h; VOC reduction decreases and NO_x reduction increases the O_3 peak concentrations around midday in the urban centres.

For the urban area Cologne-Bonn ozone episodes have been analysed for the years 1975-78 from which it is evident that for the ozone formed in this region the reactive VOC components and not NO_x were rate determining for O_3 formation. This was to be expected since in the urban areas of West Germany the condition is usually [VOC]/[NO_x] < 10.

5. Mechanism of Oxidant Formation

The only photochemical reaction which leads directly to the formation of O_3 is the photolysis of NO_2 which occurs at wavelengths below 410 nm:

$$NO_2 + h\nu \rightarrow NO + O$$
$$O + O_2 + M \rightarrow O_3 + M \text{ (very fast)}$$

The photolysis frequency, which is a measure of the photolysis probability of NO_2, is $J_{NO_2} = 7 \times 10^{-13}\ s^{-1}$ during the summer at midday in Germany.

$$d[O_3]/dt = J_{NO_2}\,[NO_2]$$

With $[NO_2] = 10$ ppb this gives an ozone formation rate of about 250 ppb/h.

However, in this case an excess of O_3 cannot be formed since O_3 is consumed again by its fast reaction with NO:

$$NO + O_3 \rightarrow NO_2 + O_2,\ k_{NO + O_3} \quad \text{(k: bimolecular reaction rate coefficient)}$$

Under photostationary equilibrium conditions when the ozone formation and destruction occur by the same rate the ozone concentration is given by:

$$[O_3]_S = (J_{NO_2}/k_{NO+O_3})\,[NO_2]/[NO]$$

with $J_{NO_2}/k_{NO+O_3} = 16$ (ppb) for summer at midday.

In such a system the cycle $NO_2 \rightarrow NO \rightarrow NO_2$ occurs many times during the day and is determined by the dimensionless quantity P_d:

$$\int_{day} J_{NO_2}\,[NO_2]dt = P_d$$

In winter P_d is around 50 and in summer it can reach values of over 250.

Formation of "excess ozone":

- by transport from areas of high ozone concentration which have been formed in upper levels of the planetary boundary layer in the previous day.
- by efficient VOC oxidation via an OH radical chain in the presence of NO_2 where NO is oxidized to NO_2 by RO_2 or HO_2 radicals and not by O_3 as mentioned above.

The mechanism shows clearly that during the step-wise degradation of VOC the chain propagation and branching steps dominate over the termination steps. Each propagation step is accompanied by a new oxidation of NO to NO_2:

$$RO_2 + NO \rightarrow RO + NO_2, k'_1$$
$$HO_2 + NO \rightarrow OH + NO_2, k''_1$$

Both of these reactions lead via the photolysis of NO_2 in sunlight to the formation of excess ozone when the rates of the reactions exceed the rate of the reaction NO + O_3:

$$\Delta[O_3]_{excess} = \{k''_1[HO_2] + k'_1\,[RO_2]\}/k_{NO + O_3}$$

From an estimation of the total concentration of the peroxy radicals formed and the measured photostationary equilibrium for $[O_3]$, [NO] and $[NO_2]$ the amount of excess ozone $\Delta[O_3]$ per day can be calculated.

An important competing reaction for the NO oxidation by RO_2 is the termination reaction with NO_2:

$$RO_2 + NO_2 \rightarrow RO_2NO_2, k_2$$
$$RO_2NO_2 \rightarrow RO_2 + NO_2, k_{-2}$$

Recent laboratory investigations within the CEC-STEP programme have shown that in particular peroxyactyl radicals, $CH_3C(O)O_2$, are effective in terminating the chain process. For peroxynitrates which do not have a -C(O)- group adjacent to O_2 the value of k_{-2} is so large that they immediately decompose again at ambient temperatures. For peroxyacetyl radicals k_{-2} is relatively small such that chain termination becomes more effective with increasing $[NO_2]$, in particular at lower temperature. The temperature dependence of k_{-2} is known from laboratory experiments; the lifetime ($\tau = 1/k_{-2}$) of PAN varies from 0.1 h at 35 ^{o}C to 12 h at 7 ^{o}C. Field measurements and laboratory studies indicate that it is this temperature dependence which causes the high ozone peak concentrations to occur when the ambient temperature is also high. Besides peroxyacetyl nitrate, peroxypropionyl nitrate and peroxybenzoyl nitrate have also been detected in air although at much lower concentrations than PAN. PAN concentrations have been measured at several sites in Europe within the COST 611-Action with peak concentrations between 1 - 10 ppb; a peak concentration as high as 34 ppb has been reported once from the Paris area. PAN is also an important indicator for the photooxidant system. The measured concentration ratio [PAN]/[O_3] in air corresponds approximately to the ratio of the chemical lifetimes of both species: thermal decomposition in the case of PAN and photolysis in the case of O_3. With decreasing temperature [PAN] will increase relatively to [O_3]. Normally [PAN] is only a few percent of [O_3]. By simultaneous measurements of [O_3] and [PAN] it is possible to differentiate between photochemically active air masses in which O_3 is formed and the advection of ozone rich air. This has been shown for an ozone episode in Rome within the COST 611-Action.

With strongly decreasing NO_x concentrations in clean air regions the chain termination steps $HO_2 + HO_2$, $RO_2 + HO_2$ and $RO_2 + RO_2$ gain significantly in importance. The $HO_2 + HO_2$ reaction forms H_2O_2 which is also an important component of the photo-oxidant system, by the reaction $RO_2 + HO_2$ organic hydroperoxides and organic acids are formed. Very recent laboratory studies within the CEC-STEP programme have shown that H_2O_2 is also formed in the direct reaction of ozone with biogenic alkenes at high humidity, particularly in forest areas, due to a reaction of the Criegee intermediates of the alkene ozonolysis with H_2O:

$$RR'COO + H_2O \rightarrow RCR'O + H_2O_2$$

Important reactions in the chain reaction scheme which lead to an increase in ozone formation are the chain branching reactions associated with the photolysis of the ketones and aldehydes which are formed in the oxidation of VOC. Only the photochemistry of formaldehyde and acetaldehyde is presently known with a reasonable accuracy, in particular by work within the CEC-STEP programme. At present the chain propagation and branching reactions involved in the oxidation of aromatics can only be speculated, though aromatic VOC components significantly contribute to the ozone formation in urban areas.

6. Contribution of Individual VOC Components on O_3 Formation

In order to formulate reduction policies it is essential to know the importance of individual anthropogenic VOC components for O_3 formation. There are different approaches to this problem which are all presently unsatisfactory because they define quantities which depend not only on the reaction time and mixing ratio of [VOC]/[NO_x] but also on the composition of VOC components. The group of Derwent has estimated from model calculations on the urban plume of London (a) and also by trajectory calculations of the transport of the air masses from West Germany to Ireland (b) specific ozone formation potentials for VOC components weighted against the emission data. The 6 most important VOC components are listed in table (2). The author (c) based the selection order on an estimation of the characteristic VOC immission data according to urban and rural areas and also on the known OH rate constants for the primary OH reactions multiplied with the number of C-atoms of the corresponding VOC component. If CO and CH_4 are taken into consideration then for large urban plumes CO would occupy the 2nd or 3rd position and CH_4 the 5th position.

Table (II): The most important VOC components with respect to their ozone formation potential and weighted by their emission rates (a, b) or immissions (c)

	(a)	(b)	(c)
1.	Xylenes	Xylenes	Xylenes/C_3-Alkylbenzenes
2.	Formaldehyde	Toluene	Toluene/Xylenes
3.	Ethene	Ethanol	C_3-Alkylbenzene/Ethylbenzene
4.	Toluene	n-Butane	Butene/Toluene
5.	2-Butene	Ethene	Ethylbenzene/Propene
6.	Propene	1,2,4-tri-methylbenzene	Propene/Ethen
with consideration of CH_4 and CO:			
2.	CO		
5.	CH_4		(urban area/rural area)

(a) A. M. Hough, AERE R 12069/Harwell 1986

(b) R. G. Derwent and M. E. Jenkin, AERE R 13816/Harwell 1990

(c) K. H. Becker and F. Zabel, unpubl. 1988

7. Conclusions

It has been shown that the formation of photooxidants in polluted urban air during summertime is a serious environmental problem in all European countries. The accelerated oxidant formation mainly characterized by the ozone peak concentration near the ground is caused by the anthropogenic emissions of carbon monoxide (CO), volatile organic compounds (VOC) and nitric oxides (NO_x). The chemical mechanisms are qualitatively known. The description of the precursor-oxidant relationship under the different atmospheric conditions and with different compositions of theVOC components needs, however, quantitative improvements.

Further research on the photooxidant chemistry is carried out in Europe within the CEC-STEP programme and also within several subprojects of EUROTRAC (TOR, LACTOZ, EUMAC) with respect to field measurements, laboratory studies and modelling. It is also planned to build a simulation chamber by which the complex chemical processes under different conditions of the atmosphere and different composition of VOC can be studied in order to evaluate and test chemical mechanisms by which the chemistry of photooxidant formation is described in numerical models. The research results should provide the basis for effective control strategies which have to be developed in order to reduce the precursor emisssions CO, VOC and NO_x in a way which takes care of the physical-chemical behaviour of the photooxidant system.

8. Literature

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   Nature 332, 240 (1988)

Brief summary of the results of the Workshop

The achievements of COST 611 (physico-chemical behaviour of atmospheric pollutants) and of COST 612 (effects of air pollution on terrestrial and aquatic ecosystems) have been extensively reviewed by respectively K.H. BECKER, University of Wuppertal, Germany for COST 611 and M. UNSWORTH, University of Nottingham, United Kingdom for COST 612.
Scientific results of COST 611 have been further illustrated by several scientists participating in this concerted action as I. Allegrini, Italy, M. Millan, Spain, O. Hov, Norway.

Mrs. C. Braun-Fahrlaender, Switzerland, gave an overview of COST 613/2, human epidemiology.

A proposal for a new COST Action on science and research for better air in European cities was presented by Swiss representatives.

Publications and project descriptions have been made available to the participants.

Scientists from Czechoslovakia, Poland and Hungary expressed their general interest in cooperating with western scientific institutions in the field of environment. Some particular problems were raised which confirmed the results of EC fact finding missions:

- *No appropriate measurements of air pollution have been made until now in these countries. The equipment and techniques for SO_2 and NOx are obsolete and almost inexistent as far as ozone is concerned; a potential for sophisticated research in the field of COST 611 needs to be developed. Funds and equipment are certainly needed, but training of young scientists and better information mechanisms e.g. identification of best available expertise at East, deserve great attention.*

- *Specific items for East-West cooperation have been identified: changes in biogeochemical cycles and soil deterioration; modification of energy and radiation balance of ecosystems due to air pollution; rehabilitation of degraded systems; epidemiology in relation to pollution.*

It is foreseen to continue COST 611 and 612 developing a cooperation with the new associated countries, but modalities need further consideration.
Knowledge about the scientific potential within the new COST-countries is an absolute necessity in order to promote the cooperation in the most appropriate way.

L. CLOSING SESSION

M. METZGER (Chairman of the COST New Projects Group)

Herr Vorsitzender, meine Damen und Herren!

Wenn ich die Diskussion des heutigen Tages zusammenfassen darf, lassen Sie mich vom Allgemeinen zum Besonderen fortschreiten. Es hat sich gezeigt, daß in allen diskutierten Bereichen großes Interesse herrscht. Es waren sehr viele Teilnehmer aus allen Mitgliedstaaten anwesend, insbesondere aus den neu in COST aufgenommenen Mitgliedstaaten. Generell kann man sagen, daß großes Interesse daran besteht, die diskutierten Bereiche fortzuführen. Dies empfinden wir als Vertreter des Ausschusses Hoher Beamter als Bestätigung, daß die ausgesuchten Themen von hohem Interesse sind.

Wichtig als Ergebnis des heutigen Workshops ist, daß von allen neu aufgenommenen Mitgliedstaaten - mehr oder weniger in den einzelnen Bereichen - der Wunsch nach Teilnahme an bestehenden, sowie an neuen, künftigen COST Aktionen geäußert wurde. Ergänzend dazu wurde deutlich, daß seitens der Institutionen aus den alten Mitgliedstaaten volle Bereitschaft, volle Akzeptanz bestand, die Wissenschaftler aus den neuen Mitgliedstaaten aufzunehmen und sie an den COST Aktionen mitpartizipieren zu lassen. Der gegenseitige Austausch wurde allgemein als befruchtend empfunden.

In diesem Zusammenhang ist wichtig zu erwähnen, daß COST weithin als sehr geeignetes Mittel betrachtet wird, die Ost-West-Beziehungen zu verbessern, zu vertiefen und am Ende auch aufzuheben, in dem Sinne, daß es keine Ost-West Beziehungen mehr sind, sondern Beziehungen zwischen Staaten Europas in einem gemeinsamen, größeren Europa.

Erfreulich ist, daß in mehreren Arbeitsgruppen neue Ideen diskutiert wurden, die zu neuen Vorschlägen für weitere Aktionen führen werden, insbesondere scheint mir das in den Bereichen Umwelt, Meteorologie und Materialforschung der Fall zu sein. Interessant war dabei auch, daß der bisher allgemein akzeptierte sogenannte "bottom-up approach" nicht mehr in dieser reinen Weise durchgehalten werden kann, sondern es stellen sich Probleme, wie etwa der Schweizer Vorschlag betreffend die Verbesserung der Luft-Qualität in europäischen Städten ein generelles Thema, das konkretisiert werden muß.

Lassen Sie mich als weitere wichtige Themen des heutigen Workshops erwähnen: das Problem der Verbreitung der Kenntnisse, das Problem der gegenseitigen Information, das Problem des Austausches von Wissenschaftlern zwischen den einzelnen Mitgliedstaaten, und - ganz wichtig - das Problem der Finanzierung. Ich bin Ihnen dankbar für alle diese Schlußfolgerungen aus den einzelnen Arbeitsgruppen, diese Schlußfolgerungen werden veröffentlicht werden und ich darf Sie alle sehr einladen, weiter Ihre Vorstellungen zu konkretisieren, zu überarbeiten und uns zu übersenden.

Wenn ich zu einem Schluß kommen darf, dann habe ich den Eindruck, daß es nützlich sein kann, so einen Workshop an anderer Stelle zu wiederholen. Das muß nicht im gleichen Rahmen, in der gleichen Weise geschehen, es könnte sein, daß es sich empfiehlt, für manche Bereiche spezifischere Themen für einen kleineren Workshop auszuwählen, es könnte sich empfehlen, die Teilnehmer zu modifizieren, beispielsweise in der Weise, daß ein bestimmter Anteil jüngerer Teilnehmer vorgesehen wird, oder in der Weise, daß ein bestimmter Anteil von Teilnehmern vorgesehen wird, die bisher noch nicht in die COST Arbeit involviert waren. Und schließlich könnte sich auch ein Workshop empfehlen, in dem auch das eine oder andere Thema diskutiert wird, was bisher noch nicht Gegenstand eines technischen Komitees war, beispielsweise in den Bereichen Medizin oder "civil engineering" oder etwas Ähnliches.
Lassen Sie mich zum Schluß als Vertreter des Ausschusses Hoher Beamter Ihnen allen sehr herzlich für Ihre Teilnahme danken, insbesondere auch den österreichischen Organisatoren dieser Veranstaltung und für die eigentlichen Schluß- und Dankesworte glaube ich, möchte ich das Wort weiter an den Präsidenten übergeben. Vielen Dank!

N. ROULET (Chairman of the COST Senior Occicials Committee)

Mesdames et Messieurs,
Nous sommes arrivés maintenant au terme d'une journée exceptionnelle qui est la première manifestation concrète de la résolution que les ministres ont signée hier. Le coup d'envoi est maintenant lancé pour une nouvelle dimension de la coopération scientifique européenne.

A la suite de cette journée intense, nous allons rentrer chacun de nous, avec des idées nouvelles, des propositions à travailler, à mettre en pratique de tous les côtés - que ce soit au niveau scientifique, administratif ou politique.

Une tâche particulièrement intéressante et nouvelle attend les scientifiques des nouveaux pays qui vont rentrer chez eux; ils auront la possibilité et c'est l'occasion maintenant de mettre en marche leur système national COST de faire en sorte que les procédures puissent se rencontrent, et au même moment, convergent pour une première génération de signatures. L'amorce est maintenant lancée.

A l'issue de cette journée, je suis confiant pour l'avenir de cette coopération qui a démarré aujourd'hui et j'aimerais terminer en exprimant toute ma gratitude aux autorités autrichiennes qui ont organisé ces deux journées extrêmement importantes, M. le Vice-Chancelier Busek, et en particulier aussi M. Kneucker, qui non seulement a joué comme il a dit le rôle de "maître de plaisir", mais qui d'une manière extrêmement active et avec des idées, des initiatives et de l'énergie a conduit les débats d'aujourd'hui. J'aimerais remercier aussi les présidents des comités techniques de toute leur préparation, leur synthèse, leur présentation, ainsi que tous les services de la Commission concernés, les secrétaires des comités techniques et des comités de gestion ici présents. Je remercie tous les scientifiques et les experts qui ont contribué avec des idées et bien sûr aussi les interprètes qui ce matin ont eu un travail particulièrement ardu. A tout le monde merci et avec mes meilleurs voeux pour l'avenir. Cette séance finale et le Forum sont terminés.

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