PRESENTACION

Este nuevo número del Boletín de SEMA que os ofrecemos, es el primero que se publica tras la legalización de la Sociedad, de la que os informamos en la circular del 14 de mayo pasado.

Esperamos que el esfuerzo de todo tipo que hay que realizar, para editar esta publicación con los escasos medios disponibles, logre, por su contenido, atraer vuestro interés y vuestra atención.

En este sentido, queremos manifestar nuestra gratitud al Profesor I. Stakgold y a los Dres. A.Abbas y J.J. Guerra (CASA) por su inestimable ayuda.

El próximo día 14 de septiembre, con ocasión del XIII CEDYA / III Congreso de Matemática Aplicada, celebraremos en la E.T.S. de Arquitectura de Madrid la primera Asamblea General en la que se elegirá el Consejo Ejecutivo de SEMA y se refrendará, en su caso, al Presidente designado, culminándose así esta etapa inicial.

En consecuencia, la actual Comisión Gestora, que se disolverá automáticamente después de la mencionada elección, se despide desde aquí - en cuanto tal- de todos los compañeros, agradeciéndoles su colaboración a lo largo de los casi dos años transcurridos desde la puesta en marcha de la Sociedad.

Junio 1993

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Activities of SIAM *

Ivar Stakgold, University of Delaware
Ex-President of SIAM (1989-90)

Quiero agradecer la amable invitación de SEMA a colaborar en este número de su Boletín.
Me complace participar en una publicación española relacionada con las Matemáticas Aplicadas. Estoy seguro de que la presente, contribuirá al desarrollo de dicho dominio científico. Mi enhorabuena.

* The information in this article has been taken in part from a new brochure "About SIAM" which can be obtained from SIAM, 3600, University City Science Center, Philadelphia, PA 19104-2688, USA.

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1. History and Goals.

The Society for Industrial and Applied Mathematics was founded in 1952 and has thus just celebrated its fortieth anniversary. What was the impetus behind the establishment of SIAM? Applied Mathematics had shown its effectiveness during World War II. Machine computation and Operations Research were fast gaining in importance in the immediate postwar period. No existing scientific society seemed to be able or willing to accommodate the aspirations of the new breed of scientists whose background varied across such disciplines as mathematics, physics, engineering and economics.

These were the circumstances leading to the founding of SIAM. Two other societies came into existence at around the same time: the Operations Research Society of America (ORSA) and the Association for Computing Machinery (ACM). The character and personality of SIAM developed in the sixties. The core of the membership was in physical applied mathematics and in numerical analysis. Among the Presidents of SIAM during that period were Joseph La Salle, Alston Householder, Barkley Rosser, Wallace Givens, Herbert Keller, and C.C. Lin. George Carrier and Joseph Keller also held major positions in the Society. Among recent Presidents, you will recognize the names of Gene Golub, William Gear, Robert O'Malley and Avner Friedman (1993-94). Although SIAM now covers more fields than ever before, its membership is still characterized by cross-disciplinary interests. Our members usually belong to at least one other major society, be it in mathematics, statistics, computer science, chemistry, physics, management science, biology or engineering.

The initial goals formulated for SIAM were to:

Advance the application of mathematics to science and industry.

Promote mathematical research that could lead to effective new methods and techniques for science and industry.

Provide media for the exchange of information and ideas among mathematicians, engineers, and scientists.

These goals sound just as appropriate today as they did forty years ago.

Applied mathematics, in partnership with computing, has become essential in solving many real-world problems. Its methodologies are needed, for example, in modeling physical, chemical, and biomedical phenomena; in designing engineered parts, structures, and systems to optimize performance; in planning and managing financial and marketing strategies; and in understanding and optimizing manufacturing processes.

Problems in these areas arise in companies that manufacture aircraft, automobiles, engines, textiles, computers, communications systems, chemicals, drugs, and a host of other industrial and consumer products, and also in various service and consulting organizations. They also arise in many research initiatives of the federal government such as those in global change, biotechnology, and advanced materials.

SIAM fosters the development of the methodologies needed in these application areas. It is fitting that the acronym SIAM also represents the society's slogan–*Science and Industry Advance with Mathematics.*

Just as applied mathematicics has grown, so has SIAM membership–from a few hundred in the early 1950s to more than 8500 today. SIAM members are applied and computational mathematicians, computer scientists, numerical analysts, engineers, statisticians, and mathematics educators. They work in industrial and service organizations, universities, colleges, and government agencies and laboratories all over the world. In addition, SIAM has over 300 institutional members–colleges, universities, and corporations.

To serve this diverse group of professionals:

SIAM publishes ten peer–reviewed research journals; *SIAM News*, a news journal reporting on issues and developments affecting the applied and computational mathematics community; *SIAM Review*, a quarterly journal of expository and survey papers; and 20 to 25 books per year.

SIAM conducts annual meetings and many specialized conferences, short courses, and workshops in areas of interest to its members.

SIAM sponsors nine (special interest) activity groups, which provide additional opportunities for professional interaction and informal networking.

SIAM sponsors regional sections for local technical activities and university (student) chapters that bring faculty and students together in activities consistent with SIAM objectives. Recently, SIAM reinstated its visiting lectureship program.

2. Publications.

SIAM publishes eleven journals and SIAM News:

SIAM Journal on Applied Mathematics
SIAM Journal on Computing
SIAM Journal on Control and Optimization
SIAM Journal on Discrete Mathematics
SIAM Journal on Mathematical Analysis
SIAM Journal on Matrix Analysis and Applications
SIAM Journal on Numerical Analysis
SIAM Journal on Optimization
SIAM Journal on Scientific Computing
SIAM Review
Theory of Probability and Its Applications

SIAM also currently publishes five book series:

Frontiers in Applied Mathematics–monographs in methodologies in practical computing, applied mathematics, and statistics for problem–solving.

Studies in Applied Mathematics–research volumes on the state of a field of applied and computational mathematics.

CBMS–NSF Regional Conference Series in Applied Mathematics–monographs derived from one–week lecture series given by mathematicians on topics of current research interest (sponsored by the Conference Board of the Mathematical Sciences with the support of the National Science Foundation).

Proceedings in Applied Mathematics–proceedings of selected SIAM conferences and those of other organizations on topics in computational and applied mathematics and computer science.

Classics in Applied Mathematics–outstanding textbooks in applied mathematics declared out–of–print by their original publishers.

In addition to these series, SIAM offers a collection of tutorials, handbooks, and reprints from its journals.

3. Activity Groups.

The members of a SIAM Activity Group share an interest in a discipline or applications area. There currently are nine groups on:

Control and Systems Theory
Discrete Mathematics
Dynamical Systems
Geometric Design
Geosciences
Linear Algebra
Optimization
Orthogonal Polynomials and Special Functions
Supercomputing

These groups plan their own activities, e.g., conferences, minisymposia at SIAM's conferences and annual meeting, and newsletters (hard copy and e-mail), with support from SIAM staff. Often the conferences are sponsored jointly with other societies.

4. Conferences.

SIAM conferences, many of which are sponsored by SIAM activity groups, focus on timely topics such as simulation, linear algebra in systems and control, dynamical systems, and material sciences. They provide a meeting place for members to exchange ideas and

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expand their networks of colleagues. Some conferences are co-sponsored with other societies, such as SODA, the annual ACM-SIAM Symposium on Discrete Algorithms.

The SIAM Annual Meeting is a week-long event that brings to the membership a broad array of invited presentations, minisymposia, contributed papers, and short courses. For 1993, the meeting will be in Philadelphia form July 12 to 16. We look forward to seeing many of our Spanish friends on that occasion.

SIAM also participates in ICIAM, the International Conference on Industrial and Applied Mathematics, held every 4 years. The first two were in Paris in 1987 and Washington in 1991.

5. Prizes and Awards.

SIAM sponsors the John von Neumann Lecture at its annual meeting and conducts an extensive prize program to recognize outstanding applied mathematicians and students. Prizes include the Richard C. DiPrima Prize, George Polya Prize, Theodore von Karman Prize, James H. Wilkinson Prize in Numerical Analysis and Scientific Computing, SIAM Prize for Distinguished Service to the Profession, SIAM Award in the Mathematical Contest in Modeling, SIAM Student Paper Prize, SIAM Activity Group on Linear Algebra Prize, and SIAM Activity Group on Optimization Prize.

SIAM also co-sponsors the George David Birkhoff and Norbert Wiener Prizes with the American Mathematical Society and the George B. Dantzig Prize with the Mathematical Programming Society.

6. SIAM Officers 1993.

Avner Friedman
Institute for Mathematics and Its Applications, University of Minnesota
President

Robert E. O'Malley, Jr.
University of Washington
Past-President

Margaret H. Wright
AT&T Bell Laboratories
Vice President-at-Large

Gilbert Strang
Massachusetts Institute of Technology
Vice President for Education

Bart S. Ng
Indiana University-Purdue University of Indianapolis
Vice President for Programs

Linda R. Petzold
University of Minnesota
Vice President for Publications

Peter E. Castro
Eastman Kodak Company
Secretary

Samuel Gubins
Academy of Natural Sciences, Philadelphia
Treasurer

I. Edward Block
SIAM
Managing Director

7. New Programs.

SIAM publications and meetings have served the academic community successfully, but have been less effective in representing applied mathematicians in industry, commerce and government. Of course those who work for IBM, Bell Laboratories, the National Institutes of Standards and Technology, and Los Alamos are often engaged in research similar to that in academic institutions and receive the same benefits from our publications and meetings as do our academic members. But what about applied and computational mathematicians who are employed by smaller firms? The industrial problems they encounter are not usually the kind that lead to publication in the SIAM Journal of Applied Mathematics, for instance. What distinguishes industrial mathematics from its academic counterpart are the give and take between engineer and mathematician, the struggle with the modeling aspects, the choice of good analytical and numerical approaches leading to acceptable answers in reasonable time, and, finally, persuasive presentation to colleagues and management.

The ECMI newsletter, the reports of the Oxford Center for Industrial and Applied Mathematics, and some of the Minnesota IMA publications on industrial mathematics give the flavor of this type of mathematics. The type of education which makes a mathematician successful in industry is not available at many institutions in the United States. SIAM is now taking a much more active role in developing guidelines for the education of industrial mathematicians. Some of the ideas being proposed are similar to those already put into practice by ECMI.

Two major national concerns have stimulated SIAM's involvement in education under the leadership of Gilbert Strang: a) the belief that American high school graduates are often weak in mathematics and science and therefore poorly equipped to join the work force. Some of the problems with productivity in American industry are blamed on inadequate education in schools and in universities; b) the economic downturn and the difficult employment picture for mathematicians. There is a painful awareness that there are no guaranteed places for applied mathematicians in industry. Universities, with a few notable exceptions, are not properly educating students for the industrial job market. At the same time, industry must be persuaded that applied mathematicians with the right attitude and education can be productive in an industrial setting.

In response to these challenges, SIAM has introduced the following new programs:

The SIAM Forum on Industrial and Applied Mathematics–an annual meeting of representatives of academe, government, and industry. Participants exchange ideas on many issues the SIAM constituency is likely to face in the years ahead, such as the requirements for success in applied and computational mathematics in industry and the improvement of educational programs to match the requirements of industry. SIAM is providing an e–mail network to Forum participants that enables them to exchange ideas and views between meetings.

Mathematics that Counts–a continuing series of articles in *SIAM News* based on results in applied and computational mathematics research that have led, for example, to increased productivity, improvements in product design, and solutions to problems related to health and the environment.

Mathematics in Industry, a study of the industrial environment for applied and computational mathematicians that should lead to recommendations for improving the match of graduate education to the needs of industry and to efforts to increase the receptiveness of industrial managers to using mathematical and computational methodologies.

8. Conclusion.

On behalf of the entire membership of SIAM, I want to repeat my congratulations on the founding of SEMA. I am sure the two Societies and their members will have a fruitful and closely knit relationship. The progress of Spanish mathematics over the last 20 years has been spectacular and I wish you continued success in the future.

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Descriptions of Some CFD Methods in Use at Construcciones Aeronáuticas S.A. (CASA).

A. Abbas and J.J. Guerra

1.1 Introduction

In the past few years, substantial progress has been achieved in the development of efficient numerical schemes for solving the Euler and Navier-Stokes equations. Accuracy and robustness of the numerical schemes have also continued to improve. Strong emphasis that has been placed on sharp representation of shock waves, which is reflected in the Euler solutions, now is focused on the accuracy of viscous flow calculations where additional attention is required.

In this section, solution methods are presented for the two-dimensional compressible Reynolds averaged Navier-Stokes equations and for the three-dimensional Euler equations. These methods have been validated, within the frame work of the EUROVAL project, against the experimental data of the RAE-2822 airfoil and the DLR-F5 wing (tunnel case) respectively.

1.2 Navier-Stokes Approach

A method for the calculation of compressible turbulent flows using general unstructured grids is described. The Reynolds averaged Navier-Stokes equations are solved by means of a cell-vertex finite volume spatial discretisation and an explicit time stepping scheme. Artificial dissipation is introduced to damp oscillations and to ensure convergence to steady state solution. An empirical remedy for the reduction of the numerical dissipation influence in the viscous wall region is employed. The Baldwin-Lomax turbulence model is used for the calculation of turbulence quantities. The method is applied to predict the turbulent flow around the RAE-2822 airfoil.

1.2.1 Governing Equations

Viscous compressible fluid flows are governed by the Navier-Stokes equations, which express the conservation principle for mass, momentum and energy. The time dependent Reynolds averaged equations in mass averaged form is used to enable the computation of turbulent flows. The additional Reynolds stress terms are modelled by introducing a turbulent eddy viscosity μ_t. For a two-dimensional flow domain with volume Ω and surface boundary $\delta\Omega$, the mean flow equations can be given in the following integral form :

$$\frac{\partial}{\partial t}\int_{\Omega} W\, d\Omega + \int_{\delta\Omega}(F\, dx - G\, dy) = 0 \qquad (1.2.1)$$

where $W = [\rho, \rho u, \rho v, \rho e]$ is the time averaged conserved variables vector. The flux vectors F and G are split into the inviscid and viscous contributions, denoted by the superscripts I and V, respectively :

$$F = F^I + F^V$$

$$G = G^I + F^V$$

where

$$F^I = [\ \rho u,\ \rho u^2 + p,\ \rho uv,\ \rho uh\ ]$$

$$F^V = [\ 0,\ \sigma_{xx},\ \sigma_{xy},\ (\ u\sigma_{xx} + v\sigma_{xy} + q_x\ )\ ]$$

$$G^I = [\ \rho v,\ \rho uv,\ \rho v^2 + p,\ \rho vh\ ]$$

$$G^V = [\ 0,\ \sigma_{xy},\ \sigma_{yy},\ (\ u\sigma_{xy} + v\sigma_{yy} + q_y\ )\ ]$$

The stress and heat flux elements are denoted by σ and q respectively. h is the total enthalpy per unit mass. The effective viscosity is equal to the laminar viscosity μ , given by Sutherland's law, plus the turbulent eddy viscosity μ_t . The standard Baldwin-Lomax turbulence model is employed to calculate the viscosity μ_t . The boundary conditions applied at the solid surface are zero normal flow, no slip and adiabatic wall. Non-reflecting boundary conditions are applied at the far field, based on the introduction of Riemann invariants for a one-dimensional flow normal to the outer boundary of the flow domain .

1.2.2 Numerical Formulation

The computational domain is subdivided into a set of polygonal cells . The numerical formulation of equation (1.2.1) involves performing flux balances for each polygonal domain which encloses each node within the triangulation (Jameson, Baker and Weatherill (1986)) . Applying the finite volume spatial discretisation , the inviscid and viscous contributions to the contour integral become :

$$\frac{dW}{dt} + \frac{1}{\Omega}\ (\ Q_k^{\ I} + Q_k^{\ V}\ ) = 0 \qquad (1.2.2)$$

where W is the conserved variables for the K-th node which defines the polygonal domain . The fluxes Q_k^I and Q_k^V are given by :

$$Q_k^{\ I} = \sum_{i=1}^{n}\ [\ F_i^{\ I}\,\Delta y_i - G_i^{\ I}\,\Delta x_i\ ] \qquad (1.2.3)$$

$$Q_k^{\ V} = \sum_{i=1}^{n}\ [\ F_i^{\ V}\,\Delta y_i - G_i^{\ V}\,\Delta x_i\ ] \qquad (1.2.4)$$

The summation process , in equation (1.2.3) and equation (1.2.4) over all polygonal domains is implemented by computing fluxes across every edge in the triangulation and sending the contributions to the nodes whose polygonal boundary contains the edge . The convective fluxes at the i-th edge are calculated , see Fig. (1) , as follows :

$$F_i^I = \frac{1}{2} \left(F_l^I + F_r^I \right)$$

$$G_i^I = \frac{1}{2} \left(G_l^I + G_r^I \right)$$

The viscous components of the summation in equation (1.2.4) involve the evaluation of derivatives of the conserved variables on each polygonal contour . These derivatives are computed using the auxiliary control volume of Fig. (1) . The derivative at i is the sum of four terms as :

$$\left.\frac{\partial u}{\partial x}\right|_i = \frac{1}{2A} \left[(u_2 + u_l) (y_l - y_2) + (u_1 + u_l) (y_1 - y_l) + (u_r + u_1) (y_r - y_1) + (u_2 + u_r) (y_2 - y_r) \right]$$

where A is the sum of areas of the two adjacent triangles which define the auxiliary control volume .

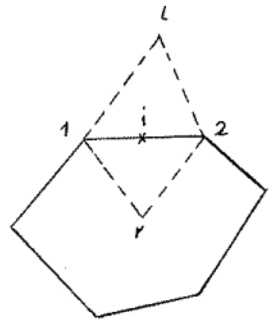

Figure (1) - Polygonal Domain and AuxiliaryControl Volume (---)

1.2.3 Artificial Dissipation

Although equation (1.2.1) contains dissipative terms , it is found that for stability of the numerical scheme this dissipation must be augmented by artificial dissipation terms . Here we employ an artificialdissipation in the form used by Mavriplis(1988), consisting of a blending of second and fourth difference operators . The basic idea of accumulated edge differences is used . This involves a term generated from a weighted difference between variables at a given node and its nearest neighbours. The weighting is adapted to gradients in the flow variables . The artificial dissipation term, D_k , is added explicitlyto equation (1.2.2) which becomes :

$$\frac{dW_k}{dt} + \frac{1}{\Omega_k} (Q_k^I + Q_k^V - \phi D_k) = 0 \qquad (1.2.5)$$

In the viscous regions adjacent to the solid surface it is important to ensure that the artificial dissipation does not dominate the real viscous effects . Therefore , it has been found necessary to introduce modifications to the dissipation terms in these regions .

The explicitly added artificial dissipation model used in the present method has the possibility of monitoring its magnitude for each individual cell by introducing an adequate scaling of the dissipation term . The present method employs a scaling parameter ϕ , as a function of the ratio of the laminar viscosity to the eddy viscosity to reduce the level of artificialdissipation in the real viscous regions . This scaling parameter is given by :

$$\phi = 1 - e^{-(\beta\mu / \mu_t)} \qquad (1.2.6)$$

In the present calculations ß is a constant which takes the value of 25 .

The discretisation procedure outlined leads to a set of coupled differential equation , equation (1.2.5) . The steady state solution of this equation is obtained by marching in time usig an explicit 3-stage scheme . Local time stepping and residual smoothing are utilised to accelerate convergence to a steady state .

1.2.4 Turbulence Model Application

The efficientcalculations of turbulent flows on unstructured grids using algebraic models is not straight-forward because the direction normal to the aerofoil surface is no longer a coordinate axis, while the value of μ_t at a point in a streamwise station is a function of the flow variables at all points in the same station .

Therefore, to calculate μ_t at a grid node one needs to draw the normal from this node to the surface and interpolate all flow variables along this normal . This may result very expensive, both in storage and CPU time, because it is only valid for the considered node and has to be repeated for each grid node .

In the present application we consider a discrete set of normals, to the aerofoil surface and the vortex sheet, to compute and store all the elements they get through. These geometrical information are calculated and stored only once and then used at each time step to calculate the eddy viscosity on each normal. The eddy viscosity at each node is then obtained interpolating the values for the nearest two points on the two neightbouring normals .

1.2.5 Numerical Details

For the present method a general unstructured triangular mesh of 16923 nodal points with 337 points on the airfoilsurface and 50383 elements is used. For the

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accurate simulation of the viscous flow in the wall region, and to be able to compare with other partner calculations , a regular structured grid is built around the airfoil in near wall region . This regular sub-grid has 25 layers with a typical distribution boundary layer calculation .

For the present calculations , the wake is initially positioned on a straight line in the direction of the unperturbed flow . This approach results in a less accurate turbulent viscosity profiles between the upper and lower parts of the wake . To correct this effect , two approaches have been used . In the first approach the wake is located on the stream line coming out of the trailing edge of the airfoil. This stream line is calculated using Euler solution and does not changed for the rest of the time steps . In the second approach , the wake is first located on a straight line coming out of the trailing edge . This line is updated every few iterations to be located on the points of maximum viscosity on the profiles across the wak .

The first approach is proved to be effective and cheap

1.3 Euler Approach

A method for the solution of the three-dimensional steady compressible Euler equations on structured grids is described . The solution is achieved by advancing the unsteady form of the equations to steady state by means of an explicit time stepping scheme (Jameson (1985)) . A cell-centred finite volume spatial discretisation technique is utilised . The convergence is accelerated by the use of local time stepping and the incorporation of implicit residual averaging . The resulting scheme is stabilised by the application of an artificial dissipation operator which is formed as a blended combination of second and fourth differences . Modifications of the basic dissipation model is also discussed

1.3.1 Governing Equations

The three-dimensional compressible Euler equations for a flow domain of volume Ω and associated boundary $\delta\Omega$ can be expressed in the form :

$$\frac{\partial}{\partial t}\int_{\Omega} W \, d\Omega + \int_{\delta\Omega} F \, ds = 0 \qquad (1.3.1)$$

where W = [ρ, ρu, ρv, ρw, ρe] is the density, rectangular components of momentum referred to a Cartesian System x, y, z fixed in space and total energy. The quantity F represents the net flux of W transported across, plus the pressure acting on it, the closed surface $\delta\Omega$. For a perfect gas, the total energy can be expressed as:

$$e = \frac{P}{(\gamma-1)\,\rho} + \frac{1}{2}\,(u^2 + v^2 + w^2)$$

In order to apply the finitvolume technique a structured grid of cells packed so that they discretise the flow field is constructed. Since equation (1.3.1) is valid for any arbitrary volume it also holds locally for each individual cell (i,j,k) in the grid. For one such cell a semi-discretisation of equation (1.3.1) leads to :

$$\frac{\partial}{\partial t} (\Omega_{i,j,k} \; W_{i,j,k}) + Q(W)_{i,j,k} = 0 \qquad (1.3.2)$$

$Q_{i,j,k}$ represents the net flux out the cell which is balanced by the rate of change of W in the cell whose volume is Ω. This flux is given by :

$$Q_{i,j,k} = \sum_{all\ faces} F \, . \, S$$

where F is the flux at the center of a cell face and S denotes the cell face area. The value of F at the cell face is taken as the average of F at the cell centers on either sides of the cell face .

1.3.2 Dissipation Model

In order to suppress the tendency for odd and even point decoupling and to capture shock waves without any overshoots, it is necessary to add a dissipative term to equation (1.3.2) . The basic model used was first introduced by Jameson, Schmidt and Turkel (1981) in conjunction with Runge-Kutta explicit schemes. Adding this dissipative term equation (1.3.2) becomes :

$$\frac{\partial}{\partial t} (\Omega_{i,j,k} \; W_{i,j,k}) + Q(W)_{i,j,k} - D(W)_{i,j,k} = 0 \qquad (1.3.3)$$

where D(w) is the artificial dissipation term which is constructed so that it is third order in smooth regions of flow. That is :

$$D(W) = (D_x^2 + D_y^2 + D_z^2 - D_x^4 - D_y^4 - D_z^4) (W) \qquad (1.3.4)$$

where:

$$D_x^2 (W) = \nabla_x (\lambda_{i+\frac{1}{2},j,k} \, . \, \epsilon^{(2)}{}_{i+\frac{1}{2},j,k}) \Delta_x W_{i,j,k} \qquad (1.3.5)$$

$$D_x^4 (W) = \nabla_x (\lambda_{i+\frac{1}{2},j,k} \, . \, \epsilon^{(4)}{}_{i+\frac{1}{2},j,k}) \Delta_x \nabla_x \Delta_x W_{i,j,k} \qquad (1.3.6)$$

Δ_x and ∇_x are forward and backward difference operators associated with the x direction . λ is the cell variable scaling factor . The coefficients $\epsilon^{(2)}$ and $\epsilon^{(4)}$ are made proportional to the normalized second difference of the pressure as follows:

$$\epsilon^{(2)}_{i+\frac{1}{2},j,k} = K^{(2)} \ max(\vartheta_{i,j,k} \ , \ \vartheta_{i+1,j,k})$$

$$\vartheta_{i,j,k} = \left| \frac{P_{i+1,j,k} - 2P_{i,j,k} + P_{i-1,j,k}}{P_{i+1,j,k} + 2P_{i,j,k} + P_{i-1,j,k}} \right|$$

$$\epsilon^{(4)}_{i+\frac{1}{2},j,k} = max[\ 0 \ , \ (K^{(4)} - \epsilon^{(2)}_{i+\frac{1}{2},j,k})]$$

$K^{(2)}$ and $K^{(4)}$ are constants with typical values of 1/4 ad 1/256 respectively. The operators in equation (1.3.4) for y and z directions are constructed in a similar manner .

The present method employs the modification proposed by Swanson and Turkel (1987) to the fourth difference term, equ. (1.3.6). This term is replaced by the following:

$$D_x^4 \ (W) = (\ \nabla_x \ \Delta_x \ ) \ (\ \lambda_{i,j,k} \ . \ \epsilon^{(4)}_{i,j,k} \ \nabla_x \ \Delta_x \ ) \ W_{i,j,k} \qquad (1.3.7)$$

This modified fourth difference term is only dissipative and does not produce any dispersive term. For this modification λ and $\epsilon^{(4)}$ are calculated at nodes rather than at cell faces.

The other modification considered in the present method is for the cell scaling factor λ . Large cell distortions, cells with high aspect ratio, can produce slow convergence and low accuracy of the numerical scheme. For such case, an anisotropic model for the evaluation of the cell scaling factor together with the introduction of functions of the cells aspect ratio have been suggested. That is:

$$\lambda_{i+\frac{1}{2},j,k} = \tfrac{1}{2} \ [\ (\bar{\lambda}_x)_{i,j,k} + (\bar{\lambda}_x)_{i+1,j,k} \ ]$$

where

$$(\bar{\lambda}_x)_{i,j,k} = \beta_{i,j,k} \ (r) \ . \ (\lambda_x)_{i,j,k}$$

and

$$\beta_{i,j,k} \ (r) = 1 + r^{\alpha}_{i,j,k}$$

$$r = \left[\frac{\lambda_x^2}{\lambda_x^2 + \lambda_y^2 + \lambda_z^2} \right]^{\frac{1}{2}}$$

In the present calculation a value of 0.8 is used for the constant α .

The discretised governing equations , equation (1.3.3) are integrated time to steady state usig 4-stage explicit time stepping scheme . Contribution from dissipation terms is evaluated at the first stage and then held constant for the remaining stages of the time step. Convergence to steady state is accelerated by using local time step and by the application of a residual averaging procedure .

$$\epsilon^{(2)}_{i+\frac{1}{2},j,k} = K^{(2)} \; max(\vartheta_{i,j,k} \; , \; \vartheta_{i+1,j,k})$$

$$\vartheta_{i,j,k} = \left| \frac{P_{i+1,j,k} - 2P_{i,j,k} + P_{i-1,j,k}}{P_{i+1,j,k} + 2P_{i,j,k} + P_{i-1,j,k}} \right|$$

$$\epsilon^{(4)}_{i+\frac{1}{2},j,k} = max[\; 0 \; , \; (K^{(4)} - \epsilon^{(2)}_{i+\frac{1}{2},j,k})]$$

$K^{(2)}$ and $K^{(4)}$ are constants with typical values of 1/4 ad 1/256 respectively. The operators in equation (1.3.4) for y and z directions are constructed in a similar manner .

The present method employs the modification proposed by Swanson and Turkel (1987) to the fourth difference term, equ. (1.3.6). This term is replaced by the following:

$$D_x^4 \; (W) = (\nabla_x \Delta_x) \; (\lambda_{i,j,k} \; . \; \epsilon^{(4)}_{i,j,k} \; \nabla_x \Delta_x) \; W_{i,j,k} \qquad (1.3.7)$$

This modified fourth difference term is only dissipative and does not produce any dispersive term. For this modification λ and $\epsilon^{(4)}$ are calculated at nodes rather than at cell faces.

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where

$$(\bar{\lambda}_x)_{i,j,k} = \beta_{i,j,k} \; (r) \; . \; (\lambda_x)_{i,j,k}$$

and

$$\beta_{i,j,k} \; (r) = 1 + r^{\alpha}_{i,j,k}$$

$$r = \left[\frac{\lambda_x^2}{\lambda_x^2 + \lambda_y^2 + \lambda_z^2} \right]^{\frac{1}{2}}$$

In the present calculation a value of 0.8 is used for the constant α .

The discretised governing equations , equation (1.3.3) are integrated time to steady state usig 4-stage explicit time stepping scheme . Contribution from dissipation terms is evaluated at the first stage and then held constant for the remaining stages of the time step. Convergence to steady state is accelerated by using local time step and by the application of a residual averaging procedure .

1.3.3 Numerical Details

For the present calculations a grid generated by DLR for the F5 wing is used. This grid was produced for the solution of Navier-Stokes equations. For the Euler solution this grid is modified eliminating the first seven planes in the viscous region around the wing surface and wake. In the wake region, from the wing trailing edge to the tunnel exit section, every second plane normal to the wake is eliminated. The surface mesh is maintained to 161x41. The total number of grid nodes used is 185x26x41.

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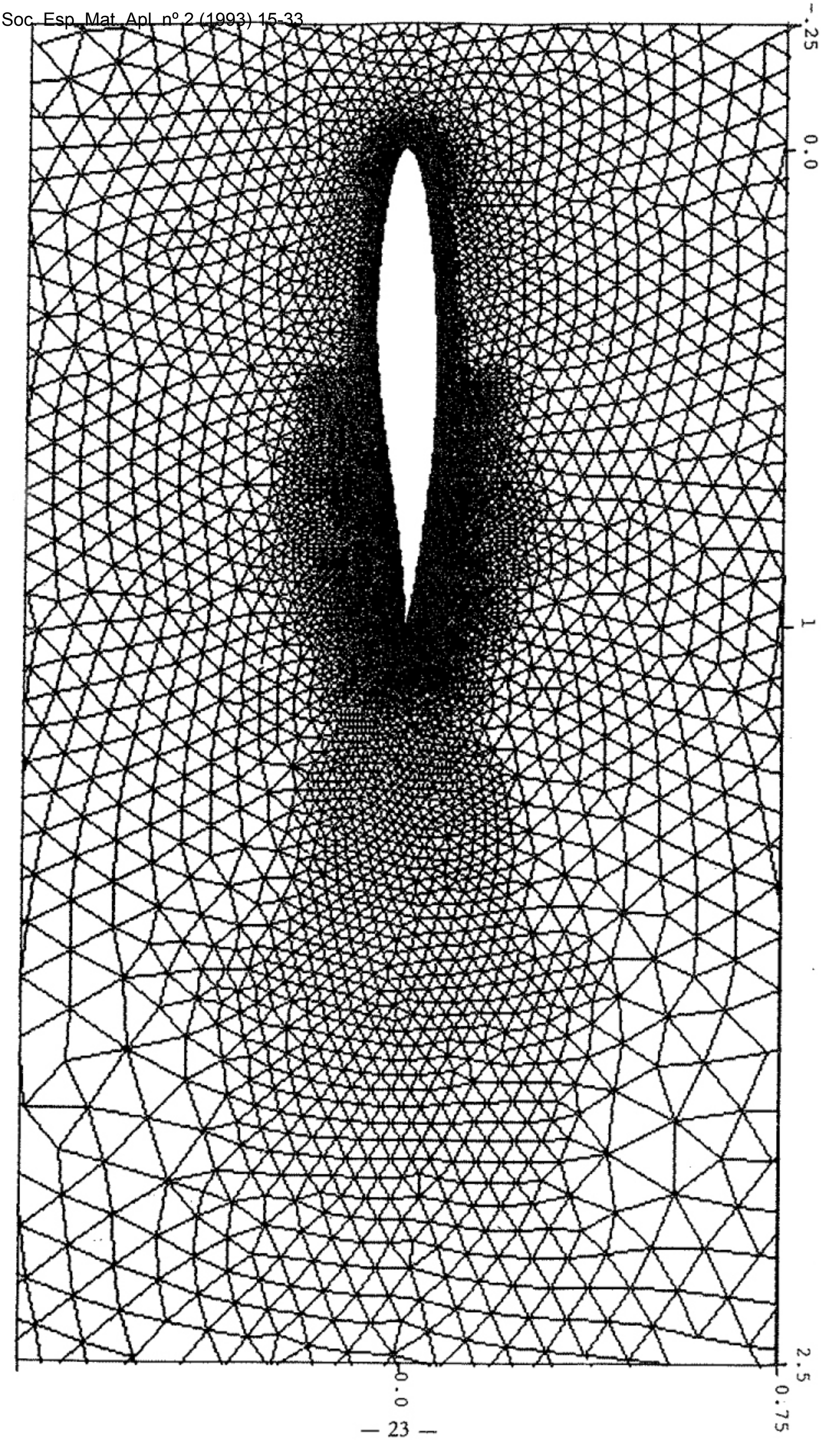
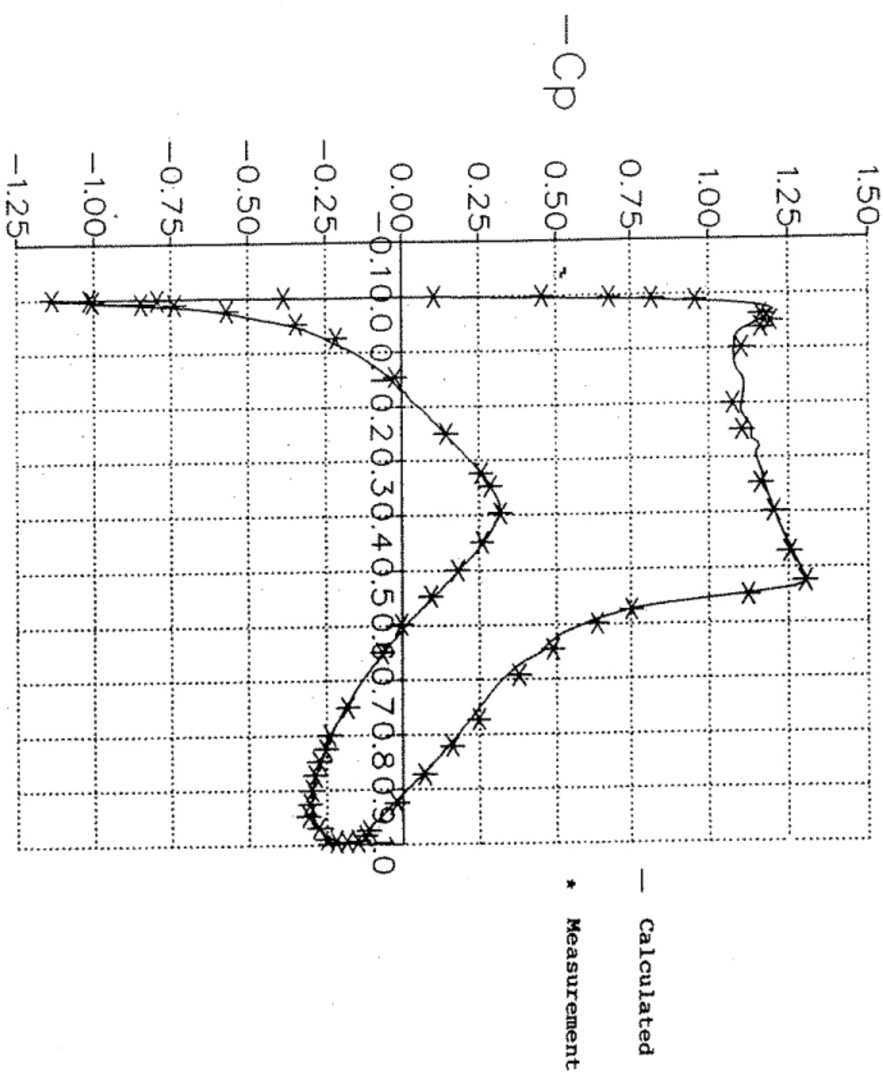
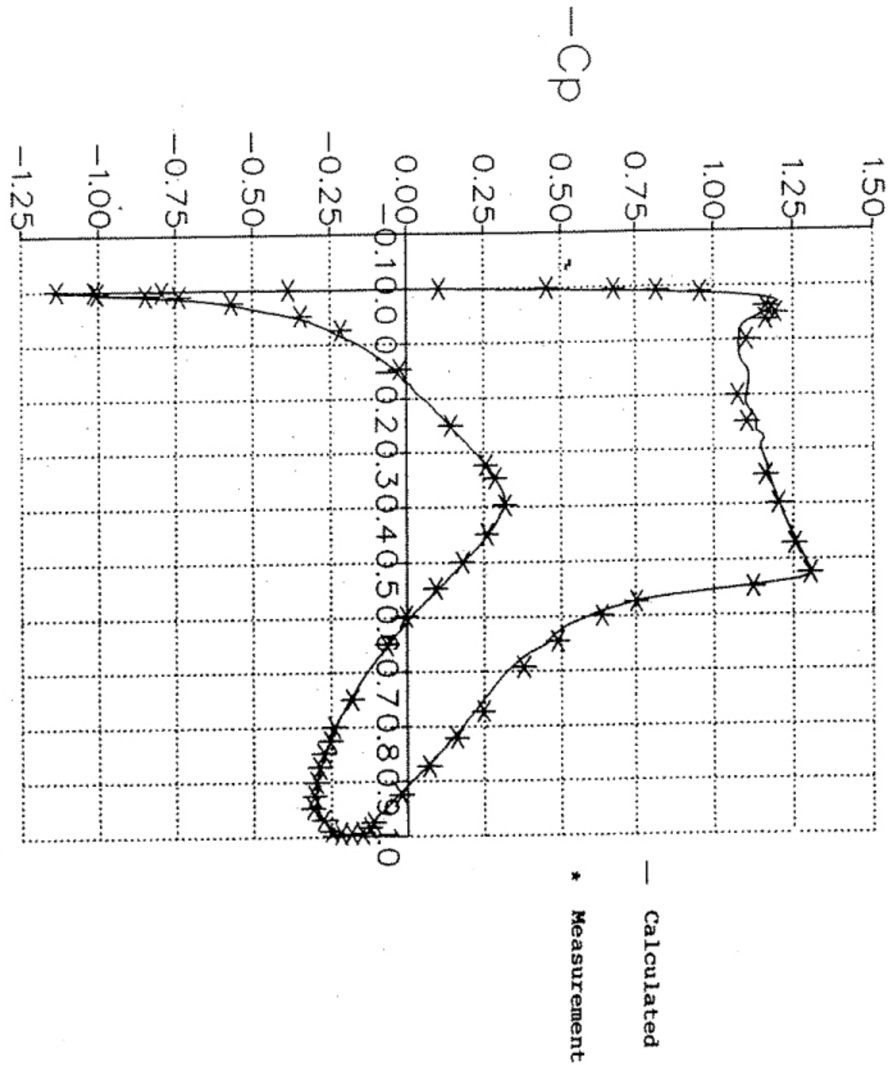


RAE 2822, CASE 9 MESH (10500 NODES, 300 ON THE SURFACE)



PRESSURE COEFFICIENT DISTRIBUTION, RAE 2822 CASE 9

M = 0.734, Al = 2.79



PRESSURE COEFFICIENT DISTRIBUTION, RAE 2822 CASE 9

M = 0.734, Al = 2.79

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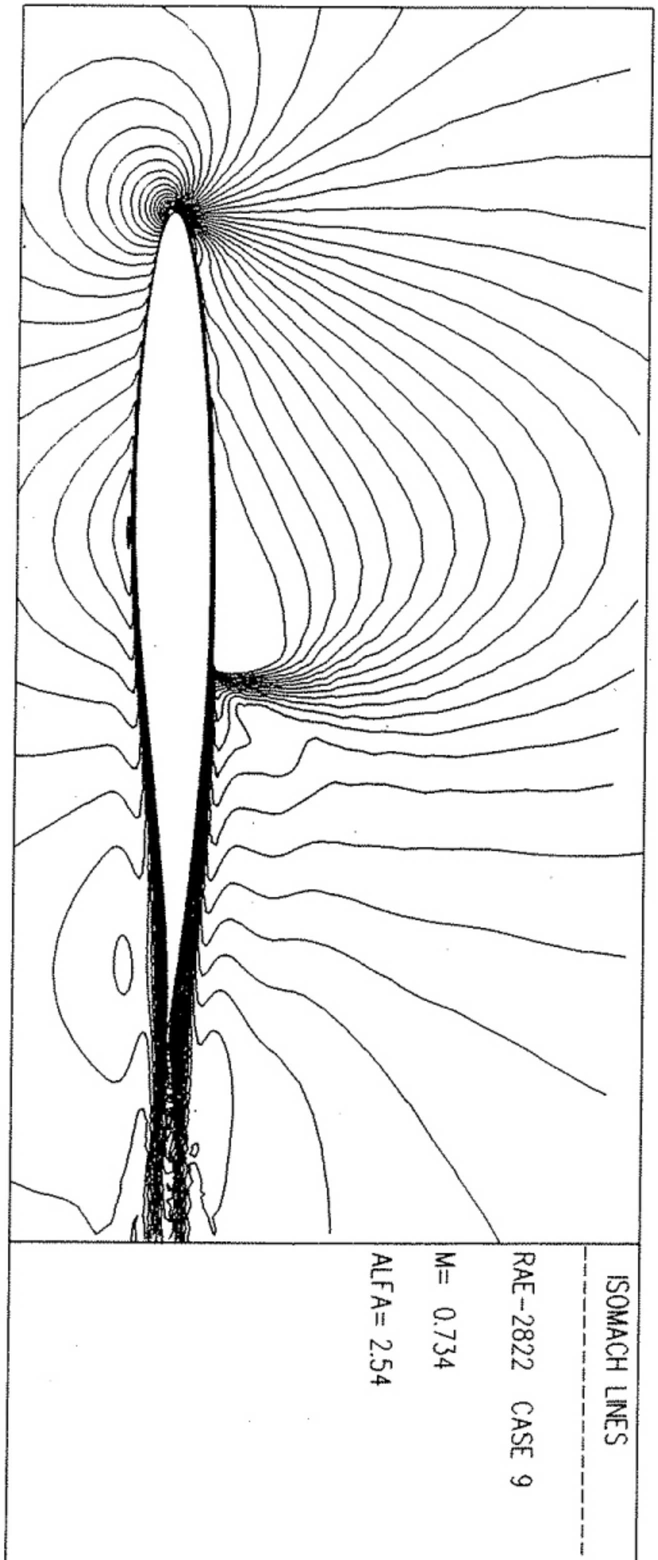
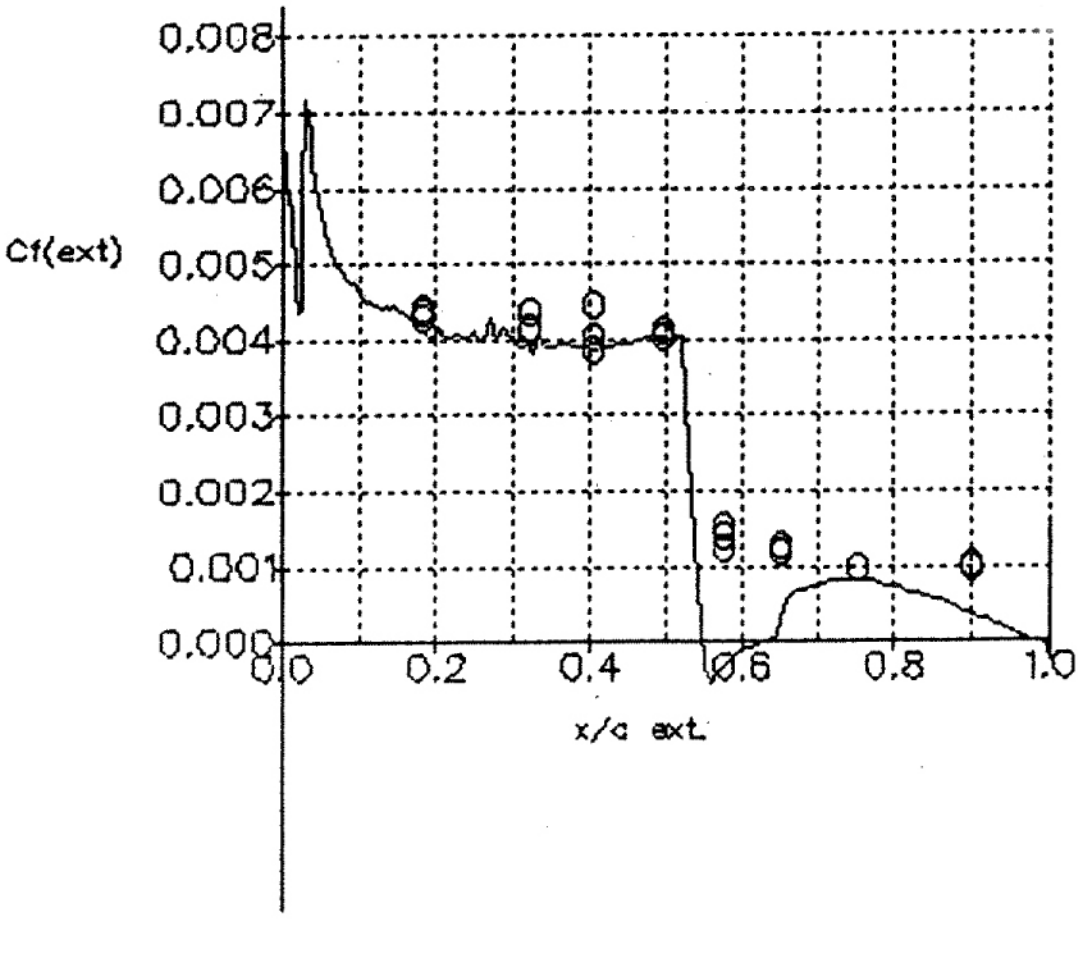
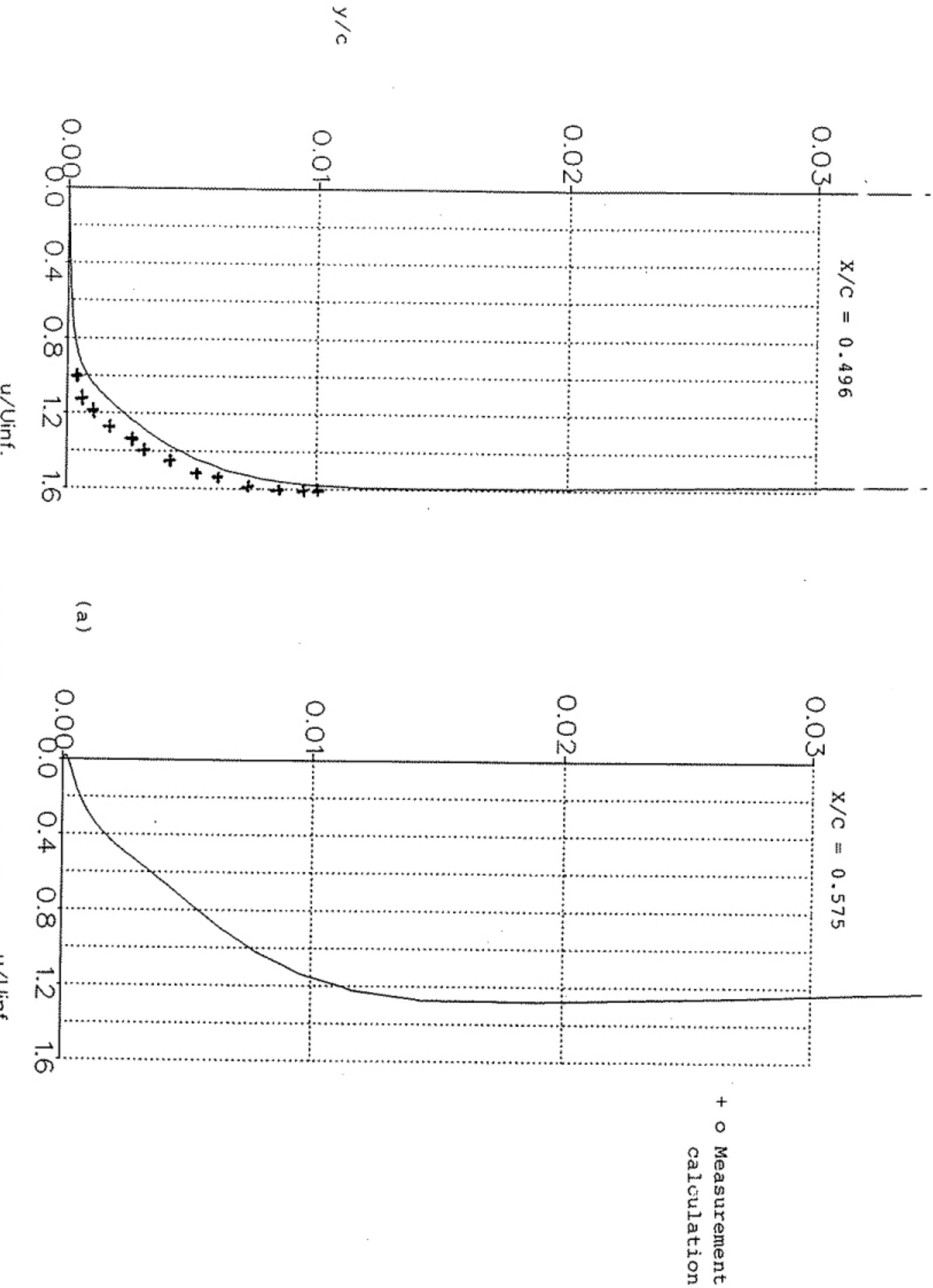


Mach Contours in 0.025, RAE 2822 CASE 9

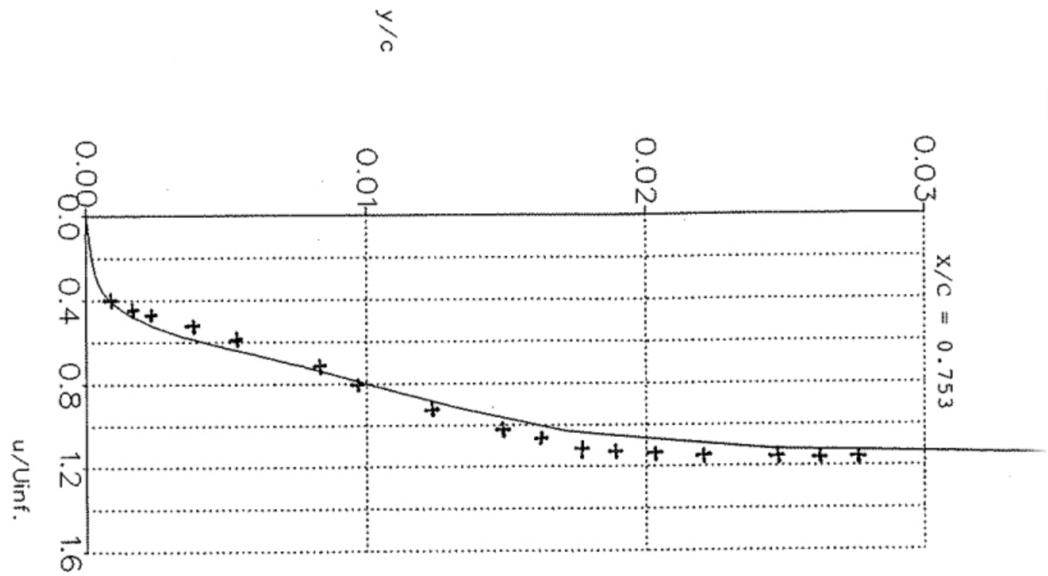


RAE 2822 CASE 9, C_f UPPER SURFACE

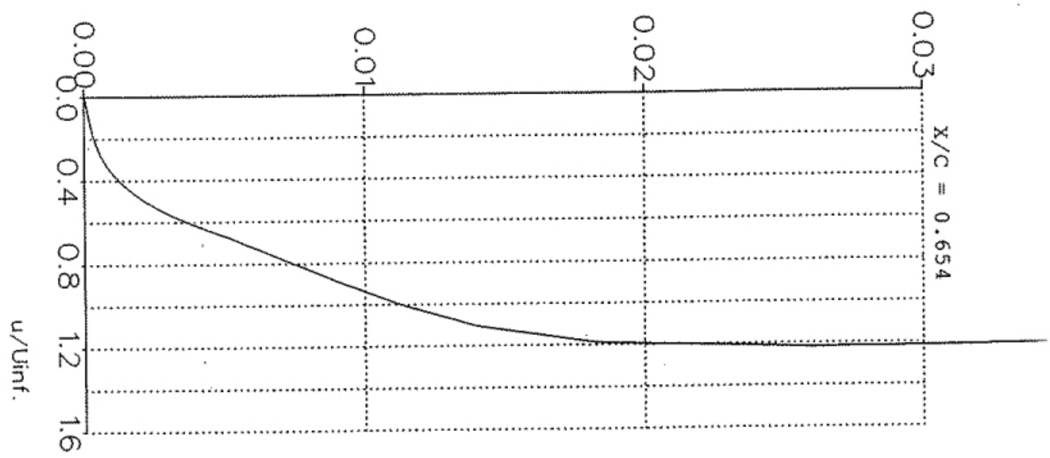
M = 0.734 al = 2.54

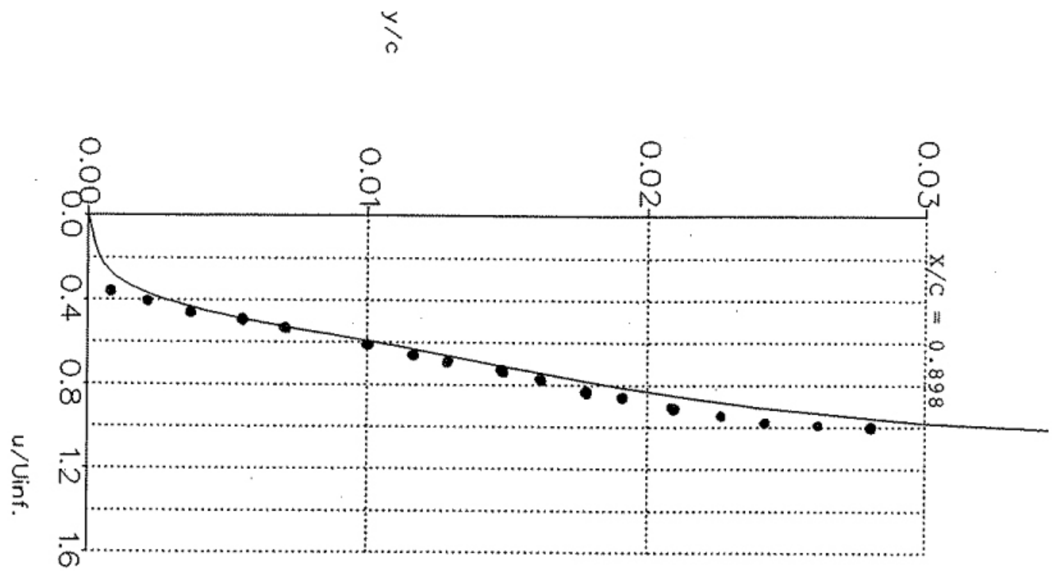


Tangential Velocity Distribution
at different station, RAE 2822

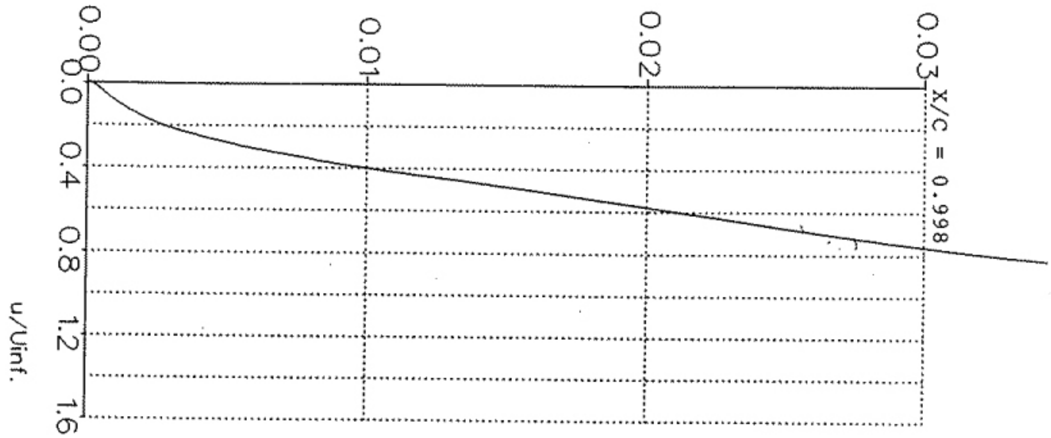

y/c
0.00
0.01
0.02
0.03
x/c = 0.753
0.0
0.4
0.8
1.2
1.6
u/Uinf.

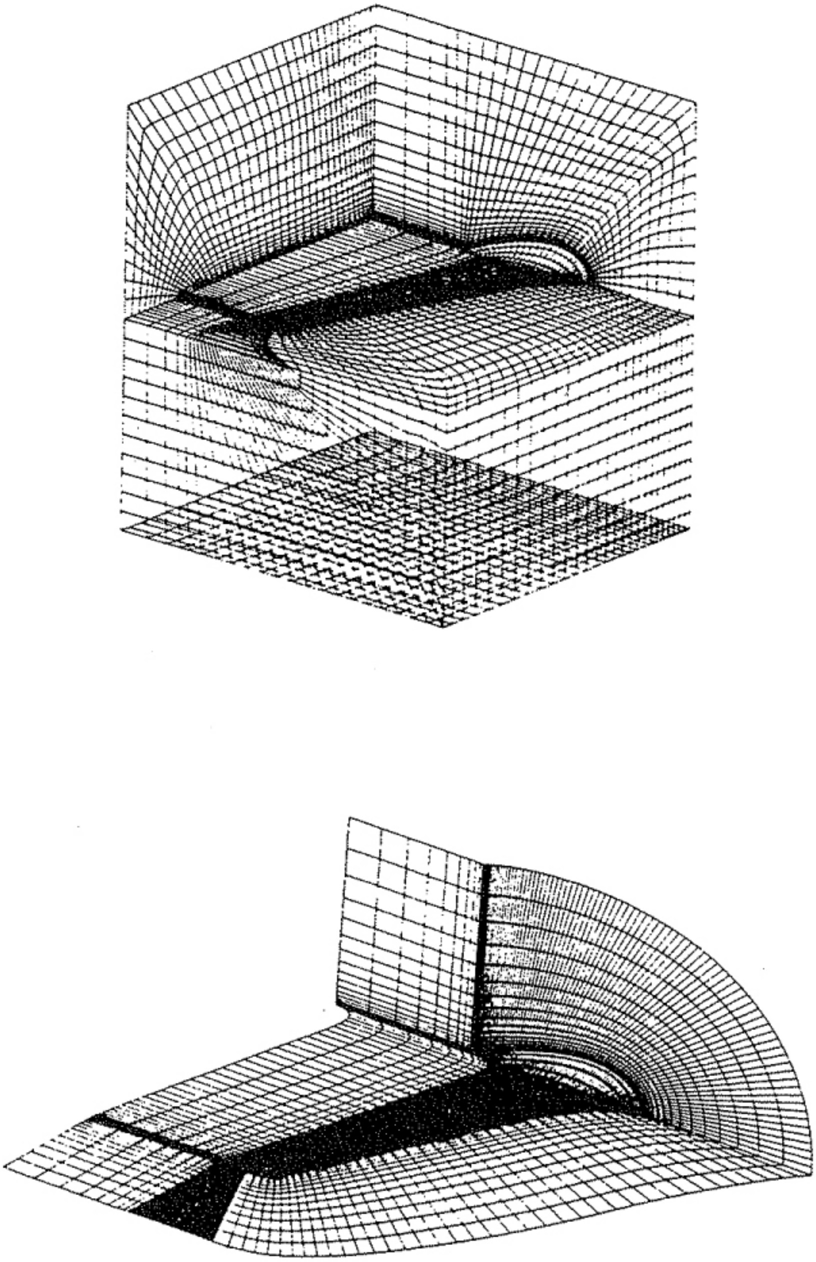
(b)


0.00
0.01
0.02
0.03
x/c = 0.654
0.0
0.4
0.8
1.2
1.6
u/Uinf.


y/c
0.00
0.01
0.02
0.03
X/C = 0.898
0.0
0.4
0.8
1.2
1.6
u/Uinf.

(c)


0.00
0.01
0.02
0.03
X/C = 0.998
0.0
0.4
0.8
1.2
1.6
u/Uinf.



Grid Distribution, DLR wing in tunnel

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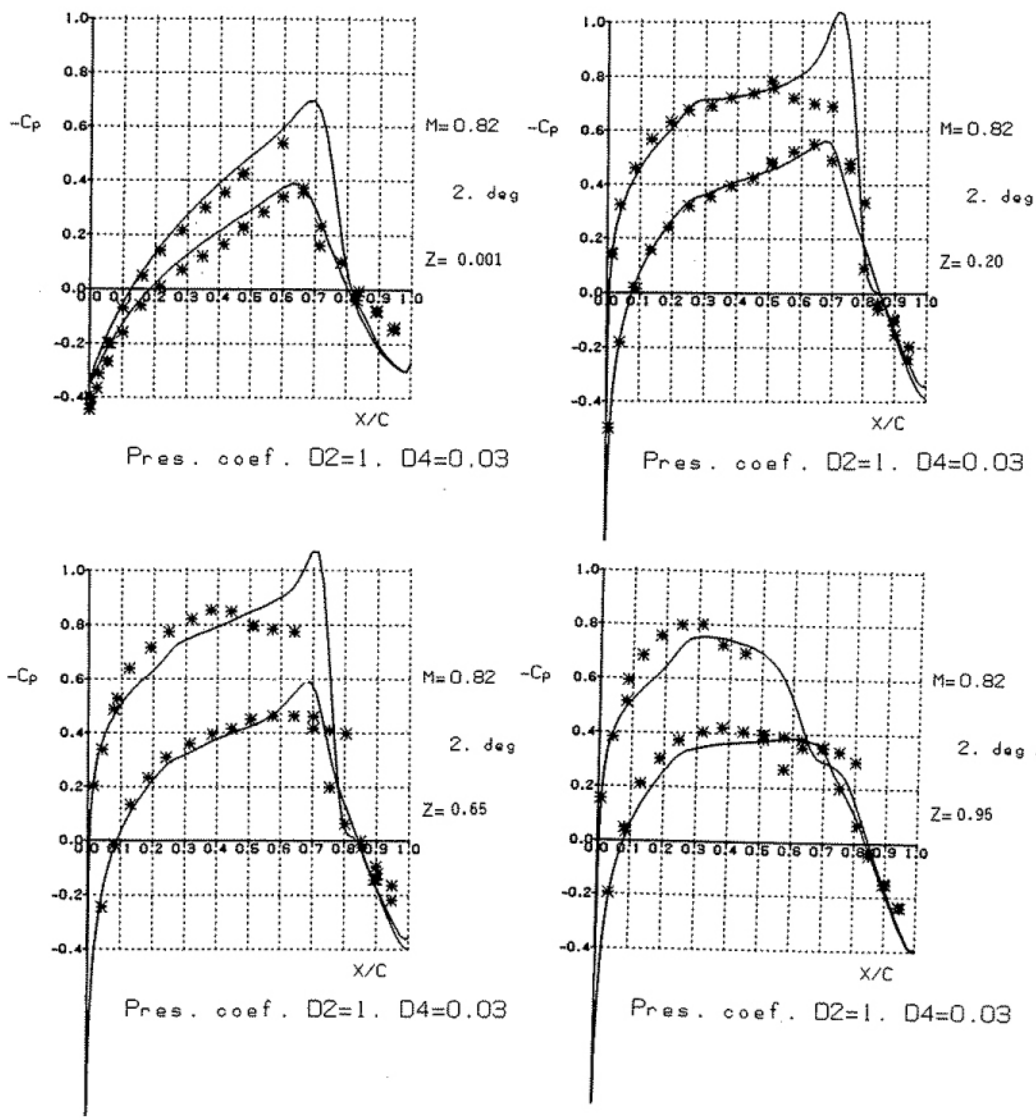
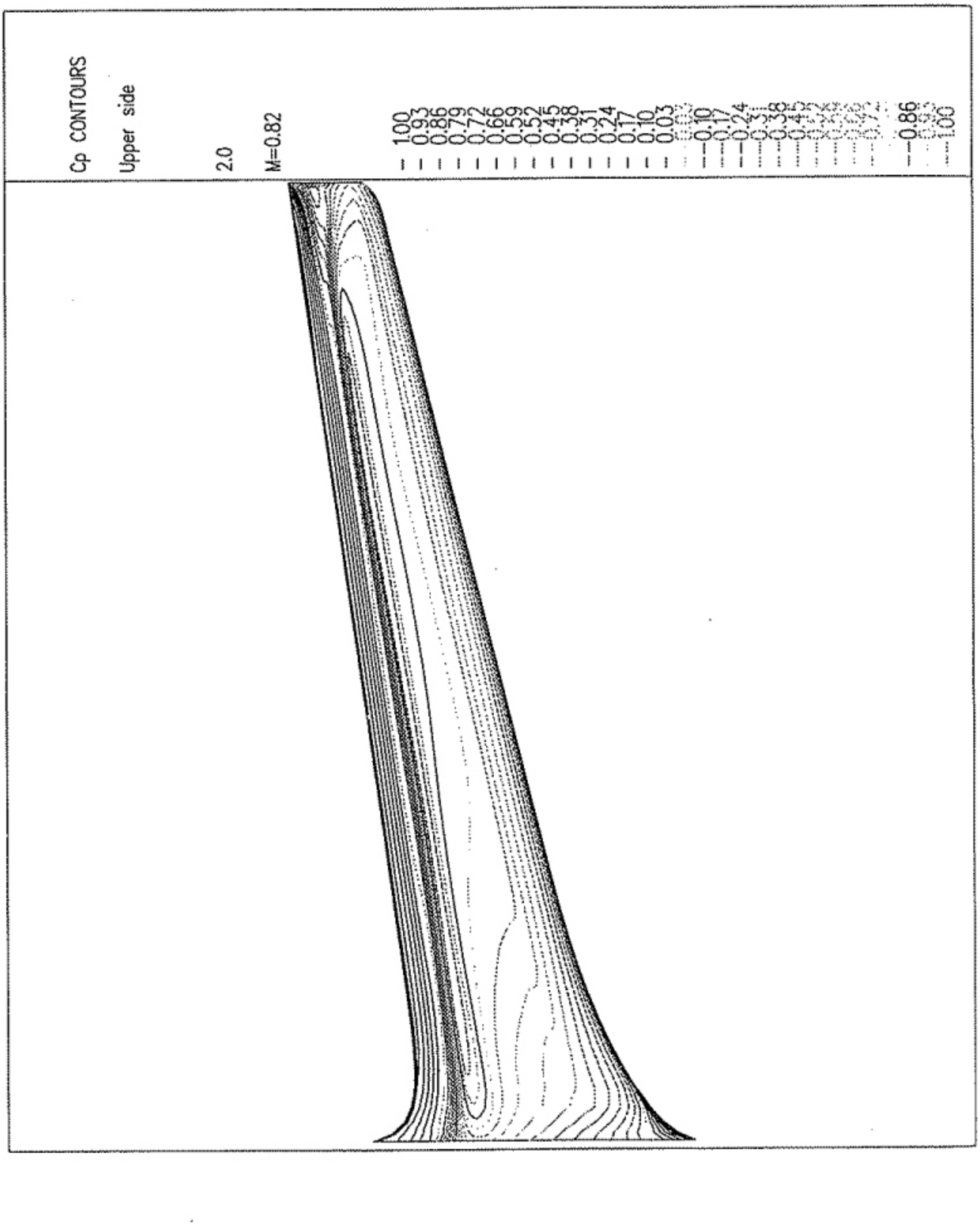
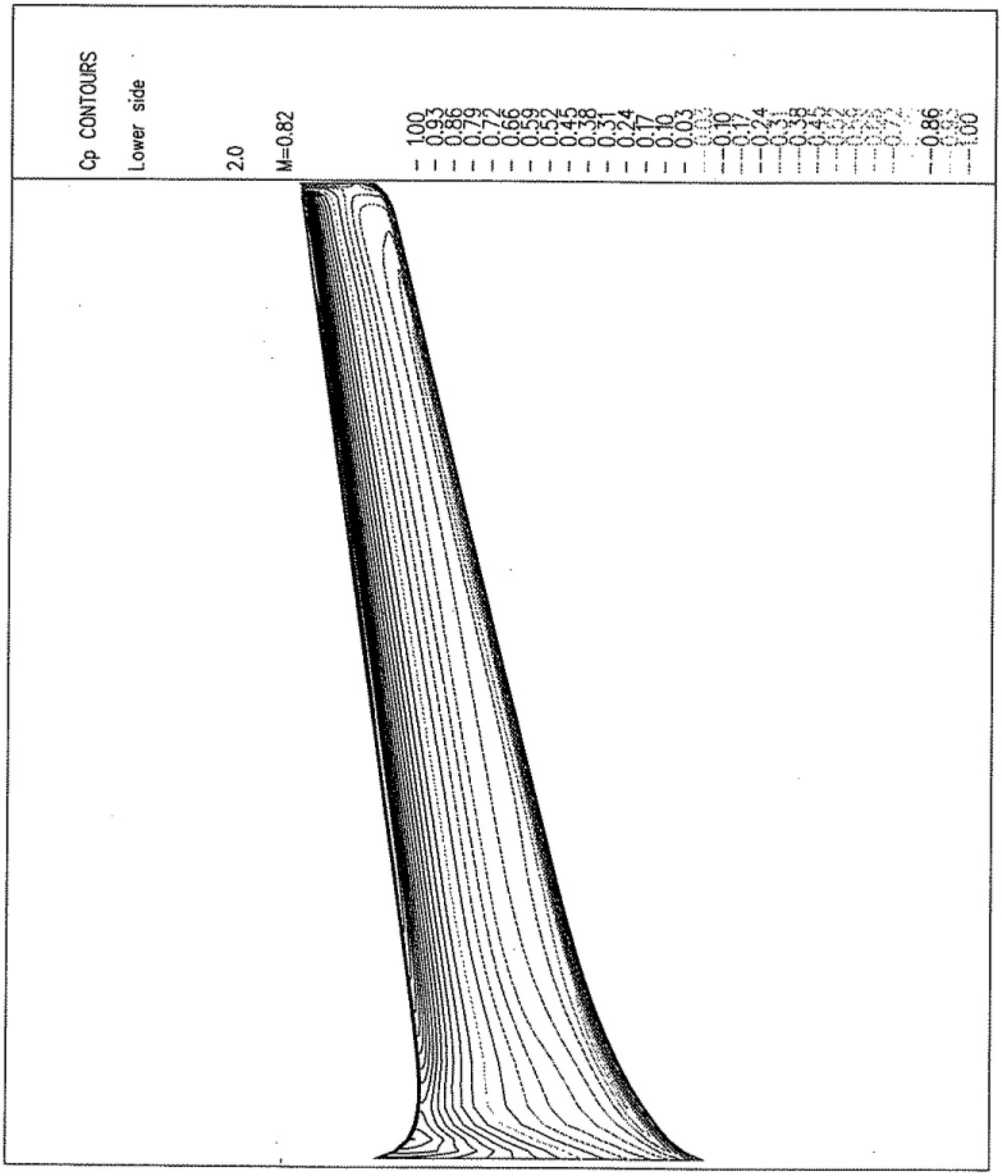


Pressure Distribution at Differen section
DLR wing in tunnel


Cp CONTOURS
Upper side
2.0
M=0.82
1.00
0.93
0.86
0.79
0.72
0.66
0.59
0.52
0.45
0.38
0.31
0.24
0.17
0.10
0.03
-0.10
-0.17
-0.24
-0.86
-1.00


Cp CONTOURS
Lower side
2.0
M=0.82
1.00
0.93
0.86
0.79
0.72
0.66
0.59
0.52
0.45
0.38
0.31
0.24
0.17
0.10
0.03
-0.10
-0.17
-0.24
-0.31
-0.38
-0.45
-0.86
-1.00

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ERCIM

European Research Consortium for Informatics and Mathematics

1. INTRODUCTION

The European Research Consortium for Informatics and Mathematics was founded by CWI, GMD and INRIA in 1988. Its membership now comprises nine leading European IT and Mathematics Institutes:

CNR Pisa	Italy
CWI	Netherlands
FORTH-ICS	Greece
GMD	Germany
INESC	Portugal
INRIA	France
RAL	United Kingdom
SICS	Sweden
SINTEF DELAB	Norway

Each institute is independent of specific commercial ties. Most have significant government funding. All have a large involvement with existing EC programmes.

It is the long-term aim that there should be one member of ERCIM from each European country. To this end a Spanish partner, AEDIMA, is due to join in 1993. Members are selected on the basis of their scientific and technical excellence in computer science and mathematics and their ability to represent the informatics and mathematics communities in the country concerned.

The objectives of ERCIM are:

(1) to promote research and training in computer science, information technology and related mathematics at a European level;

(2) to make substantial contributions to shaping future European research programmes in these fields and to identify research areas which are of particular relevance to Europe;

(3) to actively strive for a European research consortium of excellence in mathematics, computer science and technology and to coordinate research projects to complement each other in such a

way that more research areas can be covered and/or enabling others to be studied more intensively;

(4) to pool resources and know-how, thereby strengthening the European position on a global research and technology market.

A European Economic Interest Group (EEIG) has been set up by the ERCIM partners to provide a framework for ERCIM activities. In some cases, this EEIG is pioneering the involvement of government laboratories in EEIGs. The ERCIM-EEIG will be the contractual agent for ERCIM's involvement in EC-funded projects and, in particular, the Human Capital and Mobility Fellowship Programme.

2. AEDIMA

AEDIMA (the Spanish Association for Informatics and Applied Mathematics) is a consortium consisting of eleven Spanish universities and four Research Institutes of the "Consejo Superior de Investigaciones Cientificas". AEDIMA universities are:

(1) University of Barcelona (UB)
(2) Autonomous University of Barcelona (UAB)
(3) Polytechnical University of Catalonia (UPC)
(4) University of Granada (UGR)
(5) University of Malaga
(6) University of Madrid (Complutense)
(7) Polytechnical University of Madrid
(8) University of Santiago de Compostela (USC)
(9) University of Sevilla
(10) University of Valladolid (UV)
(11) University of Zaragoza

The Research Institutes are:

(1) Instituto de Automatica Industrial, CSIC-IAI
(2) Instituto de Cibernetica, CSIC-IC
(3) Centro de Estudios Avanzados de Blanes, CSIC-CEAB
(4) Centro Nacional de Microelectroonics, CSIC-CNM

The AEDIMA partners signed the agreement for the Constitution of AEDIMA on November 24, 1992 (*).

(*) Miembros de SEMA que forman parte de los órganos de gobierno de AEDIMA:
V. Camarena (Univ. de Zaragoza), miembro del Consejo Directivo y de su Comisión Gestora.
A. Bermúdez de Castro, representante de la Univ. de Santiago en el Comité Científico y miembro de su Comisión permanente.
A. Valle, representante de la Univ. de Málaga en el Comité Científico.

3. ACTIVITIES

ERCIM activities currently include:

(1) A Fellowship Programme to enable a limited number of young researchers to spend six months in each of three of the ERCIM institutes. This is described in more detail in the next section. This programme is currently enhanced by additional Fellows funded under the CEC Human Capital and Mobility programme.

(2) A Workshop Programme. Currently workshops are held every six months on a wide variety of topics. Typically 3 workshops are held in parallel, attended by a total of around 150 people from the ERCIM institutes. These workshops provide an opportunity for scientists in the individual countries via the ERCIM institutes to share information on their activities and to consider opportunities for joint projects and other forms of collaboration. Scientists outside ERCIM are invited to participate as appropriate.

(3) A Newsletter published four times a year. The Newsletter enables information to be disseminated amongst the Institutes and the European academic and industrial sectors concerning current and future projects being undertaken by the ERCIM members, news of staff, forthcoming events, etc. The Newsletter has a large distribution both inside and outside the ERCIM institutes.

(4) Working Groups in computer graphics, databases and networking have been formed as a result of earlier workshop activities. These working groups address topics of joint scientific interest through workshops and other channels (such as electronic mail) as appropriate. The computer graphics group held a series of three specialist workshops during 1990/91 to formulate joint ideas about a next generation of international (ISO/IEC) standards in computer graphics, an area in which five of the ERCIM institutes have long-standing activities. The database group has devised a programme of specialist workshops addressing specific topics of common interest in the database field. The first of these, on database theory was held at CWI in October 1991. The second, on scientific databases, will be held at RAL in July 1992 and the third on incomplete databases will be held at CNR in September 1992. The networking group has been looking at the short and long term needs of the ERCIM institutes, to achieve closer and hopefully cooperative working. Other Working Groups are being formed.

(5) Advanced Courses Programme. ERCIM has organised a number of advanced courses which have been repeated in several of the countries represented in ERCIM. Topics have included: Principles

and Practice of Advanced User Interfaces, Large Scale Scientific Parallel Computing and Partial Differential Equations and Group Theory. The courses have been organised with support from the CEC under the COMETT II programme.

(6) The Directors of the ERCIM institutes meet formally at least twice a year alongside the bi-annual workshops. The Directors meeting addresses questions of policy for ERCIM. The day-to-day operation of ERCIM is under the control of an ERCIM Executive Committee, consisting of one senior staff member per organisation, whose role is to implement the policy agreed by the Directors, through the ERCIM Management and supporting staff.

4. FELLOWSHIP PROGRAMME

The ERCIM Fellowship Programme was launched in 1990, to enable young scientists to spend six months in each of two (later extended to three) of the ERCIM institutes. The motivation behind the Fellowship Programme was similar to the motivation of the CEC Human Capital and Mobility Programme *to help to increase the human resource in quality and quantity in the field of research and technological development*. An equally important objective was to allow young researchers to experience the working environments and practices of different leading European institutes. A third objective was to promote cross-fertilisation and cooperation between research groups working in similar areas in different laboratories, through the Fellows. Thus, there is a linkage between the Fellowship programme and the Working Groups. The aim is that Fellows will contribute, as trainees at the three institutes, to three aspects of a joint programme. These joint programmes may involve collaboration with other institutes and universities. It is feasible that some part of the Fellowship can be located external to an ERCIM institute. The ERCIM Fellows also participate in the workshop programme which provides a further opportunity to establish contacts and cross-links and to foster collaboration.

The number of Fellows appointed is constrained by the funds available. Six Fellowships were awarded in the 1992 round, there were a further 48 candidates who could be accepted as ERCIM Fellows, if funds were available. Of these, a further 10 fellowships were subsequently funded by the CEC Human Capital and Mobility Programme. These Fellowships were for up to 2 years in duration.

Each year, a brochure and posters announcing the Fellowship Programme are widely distributed to universities, research laboratories and industrial R&D organisations in Europe and beyond. Each application is reviewed by one or more senior scientists in each of the ERCIM institutes. The result of this process is a short-list of candidates which each institute would accept. The ERCIM Fellowship secretariat then match the short-listed candidates to the requirements of the Programme, including the fact that each candidate should work in each of three of the ERCIM institutes. The ERCIM Executive Committee considers the results of the short-listing process and decides to which candidates Fellowships should be offered. In so-doing, care is taken to create a proper balance between the number of candidates assigned to each institute, the fields of scientific interest spanned by the candidates and the nationalities of the candidates. Fellows will normally be p[aid direct by ERCIM. The French organisation, CIES, is used as the agent in such transactions.

5. INTERNAL MOBILITY

The ERCIM Directors have established an internal ERCIM exchange programme, to enable a young scientist in one ERCIM institute to spend a period of time working with colleagues in another institute. The potential benefits are in terms of cross-fertilisation, establishing bases for future collaborative projects and training. Each partner has agreed to fund 6 man-months of internal mobility in 1993.

6. AREAS OF RESEARCH

It is inappropriate to summarise the state of knowledge in all possible areas in which ERCIM Fellows might work. A selection of the key research areas in which ERCIM institutes are active is listed below. ERCIM has internationally acclaimed research teams in each (see Annex).

Complexity and Algorithms: parallel and sequential algorithm design, probabilistic algorithms, and theory of complexity.

Computational Linguistics: natural language processing, lexical databases, textual corpora.

Computer Graphics and Scientific Visualisation: systems design, algorithms and data structures, formal description techniques, theory of, visualisation techniques, environments.

Computer Supported Cooperative Working: sharing, co-authoring, organisational issues, user interfaces.

Concurrency: concurrency theory, distributed concurrency control, verification of concurrent systems, concurrent real-time systems.

Databases: object-oriented and heterogeneous databases, data models, database architecture.

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Decision Support Systems: theory, methodology and applications of decision support systems.

Distributed Systems techniques: for the design, analysis and construction of complex transparent, fault-tolerant, real-time distributed systems.

High Speed Networking: protocol development, applications, performance evaluation, network management.

Image Processing and Computer Vision: sensing, processing, presentation, analysis, synthesis, and interpretation of digital images; human-level visual capabilities for computers and robots.

Information systems: quality support throughout the development process

Interactive Systems: techniques for the design and analysis of interactive systems.

Knowledge Engineering: knowledge representation, non-monotonic reasoning, default reasoning, cognitive modelling, robot planning.

Logic Programming: theory and foundations, language extensions, programming methods and tools, logic databases, applications.

Multi-media Systems: operating systems and architectural issues, multi-media information modelling, multi-media information retrieval, hypertext/hypermedia systems, navigation.

Numerical Linear Algebra: parallel algorithms, complexity of numerical linear algebra problems, structured matrix computations

Parallel Systems: algorithms, architectures, theory of parallel systems, transputer-based systems.

Performance Analysis: distributed systems, queuing theory.

Scientific Computation: parallel algorithms, partial differential equations, computer algebra.

Software Engineering: formal methods, specification and proof, term rewriting systems, functional and logic languages.

System and Control Theory: stochastic systems, deterministic systems, discrete event systems.

VLSI Design: CAD tools for chip and system design, simulation techniques, algorithms and structures, VLSI complexity theory, testing methods and tools.