# NASA - Langley

## HIGH-SPEED AIRCRAFT DIVISION

### ROUTING SLIP

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Comments or reply by __________

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Information and return to circulation

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Information and section files

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Please keep only ________ days
August 1, 1972

Mr. Frank P. Smith
Office of University Affairs
Code Y
National Aeronautics and Space Administration
Headquarters
Washington, D.C.

Dear Mr. Smith:

We wish to submit the following revised research proposal on behalf of New York University:

TITLE: Numerical Design of Transonic Shockless Airfoils

PRINCIPAL INVESTIGATOR: P.R. Garabedian

AMOUNT $70,000

ACTION REQUESTED: Renewal of Grant No. NGR-33-016-167

PERIOD: September 1, 1972 to August 31, 1973

We enclose a summary of progress made so far, our proposed research for the future, and a detailed one year budget.

New York University represents that no company or person, other than a full-time member of its staff, has helped solicit or secure this grant. I certify that the distribution of costs between the direct and indirect categories, as shown in the proposal, conforms to the usual accounting practices of the Institution for all federally supported or sponsored research.

An overhead rate of 66% of salaries is used for the period after August 31, 1972, as per our agreement with D. H. E. W..
We wish to express our thanks for your interest and support of our research program.

Sincerely yours,

Louis Nirenberg
Director

P.R. Garabedian
Principal Investigator

LN:as
Enclosures

cc: Dr. Richard T. Whitcomb, NASA
Mr. Jerry South, NASA
Dr. S.R. Bland NASA
NASA NOTICE FOR HANDLING PROPOSALS

(October 1969)

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Continuation of Grant NGR-33-016-167
Revised Budget
September 1, 1972 to August 31, 1973

SALARIES:

Professor Paul Garabedian
(Principal Investigator)
8-1/3% 9 Months Academic Year
(NYU will cost share 8-1/3% during this period) $ 2,708

Associate Professor Samuel Burstein
100% 2 Summer Months 3,722

Antony Jameson
Sr. Research Scientist
66-2/3% 12 Months 14,667

David Korn
Research Scientist
50% 12 Months 8,500

Frances Bauer
Research Scientist
33-1/3% 12 Months 5,333

1 Secretary
50% 12 Months 3,000

TOTAL SALARIES $37,930

OVERHEAD (66% of salaries) 25,034*
FRINGE BENEFITS (13.5% of salaries 5,121
TRAVEL 900
PUBLICATIONS 1,000
MISCELLANEOUS (Communications, supplies, etc.) 15

TOTAL $70,000

*The above overhead rate does not include 4% of cost sharing or $1,517 representing the University's contribution.
Numerical Design of Transonic Shockless Airfoils

Summary of Progress and Proposed Research

We have now completed a major report on the two-dimensional theory of supercritical wing sections. This runs to more than 200 pages and includes a users manual as well as the complete listing of our design and analysis computer programs. Decks for the programs have been delivered to the Langley Research Center and have been run successfully on the CDC 6600 there. Using the latest version of the programs an engineer should be able to design efficient transonic airfoil shapes with relative ease.

In the forthcoming year we would like to extend our analysis program so that it can be applied to three-dimensional flows. We have been aided recently by Antony Jameson and we plan to add him to our team next year. Preliminary work on new difference schemes which retard parallel to the direction of flow indicates that we can achieve convergence with our analysis program all the way to Mach 1. These new schemes converge more rapidly than our earlier ones, and in some cases have cut computing time by a factor of five. These preliminary studies indicate that it is feasible to do fully three-dimensional flows around airplane wings. Therefore we intend to write an analysis program to handle swept and unswept wings with finite aspect ratio.

Langley Research Center has indicated interest in studies of time-dependent transonic flow. During the next year we should like to carry out an investigation of such phenomena. To this end we plan to
add Professor Samuel Burstein to our team. He has ample experience in the numerical analysis of time-dependent flows based on various modifications of the Lax-Wendroff finite difference scheme. It is our intention to use such schemes to study time-dependent transonic flow in a nonlinear context. Our point of departure will be the examples of steady shockless flow past transonic airfoils that we have already developed.

There are a number of other problem areas that we could look into if time allows. It would still be desirable to have a boundary layer correction for our analysis program that would remain valid through weak shock waves.

We would also like to extend our design programs so that they can be applied to the problem of designing transonic compressor blades.

P.R. Garabedian
Principal Investigator