OPTIMA

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A GIFT FOR ALEXANDER!

AT PLAY IN THE FIELDS OF SCHEDULING THEORY

E.L. Lawler
University of California, Berkeley

J.K. Lenstra
Mathematisch Centrum, Amsterdam

A.H.G. Rinnooy Kan
Erasmus University, Rotterdam

Machine scheduling theory is something of a jungle, encompassing a bewilderingly large variety of problem types, as the most cursory examination of the journals reveals. It is also a marvelous playground for the algorithm designer and the complexity analyst, in that every known trick of combinatorial optimization can be applied somewhere, to one problem or another. This is an account of our explorations of this jungle-playground. Not incidentally, we shall describe a computer program we have used to help us guide our way. We conclude with some speculations about how similar, possibly more sophisticated, programs could be useful aids for researchers in other fields.

When we began our collaboration several years ago, we decided to focus our attention on *machine* scheduling problems. This meant that we excluded from consideration such worthy topics as project scheduling, timetabling, and cyclic scheduling of manpower. We also decided to concentrate on strictly *deterministic* models. Even so, this left us with an enormous number of problem types to study.

Very early on in our investigations, we decided we needed a uniform system of classification for the problems which had appeared in the literature. Starting from the classification scheme of Conway, Maxwell and Miller [1], after much debate we settled on a scheme which suited our purposes. This classification system is detailed elsewhere [4], and for present purposes can be summarized as encompassing ***machine environment*** **(single machine, parallel machines, open shop, flow shop, job shop),** ***job characteristics*** **(independent vs. precedence constrained, etc.), and** ***optimality criterion*** **(makespan, flowtime, maximum lateness, total tardiness, etc.).**

An immediate payoff was the consummate ease with which we could communicate problem types. Visitors to our offices were sometimes baffled to hear exchanges such as: "Since $1|r_j|\Sigma C_j$ is NP-hard, does that imply that $1|pmtn,r_j|\Sigma C_j$ is NP-hard too?" "No, that's easy, remember?" "Well, $1|d_j|\Sigma C_j$ is easy and that implies $1|pmtn,d_j|\Sigma C_j$ is easy, so what do we know about $1|pmtn,r_j,d_j|\Sigma C_j$?" "Nothing."

As this discussion indicates, one of our objectives was to demark as clearly as possible the boundary line between ***easy*** **problems (solvable in polynomial time) and** ***NP-hard*** **problems. But because of the huge number of problem types and the relationships between them, it was easy to become confused. One could spend an hour trying to determine the status of a particular problem, only to realize that the issue had already been resolved - the problem was a generalization of a known NP-hard problem and therefore NP-hard as well, or a specialization of a known easy problem and therefore easy as well.**

The idea of using the computer as an aid began as a joke. The afternoon of September 22, 1975, **Dick Karp, Ben Lageweg, Gene Lawler** and **Jan Karel Lenstra** met in the Mathematical Center in Amsterdam to decide on a gift to present to **Alexander Rinnooy Kan** on the occasion of his upcoming promotion to doctorate. Somebody made the amusing suggestion of a bound volume consisting of a computer tabulation of all the thousands of problem types with a notation for the status of each one: * for easy, ! for NP-hard, and ? for unresolved.

We were well aware that the problems in our classification system admitted of a natural partial ordering. Job shops are more general than flow shops. Precedence constrained problems are more general than

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Welcome To Bonn

It is a great pleasure for us to welcome the participants of the XI. International Symposium on Mathematical Programming on behalf of the program and organizing committee here at the Rheinische Friedrich-Wilhelms-Universität Bonn.

This triennial scientific meeting of the Mathematical Programming Society is one of the best occasions for all researchers in the area to assemble and interchange ideas. We expect participants from Universities, research institutions, and industry from about 40 different countries and thus hope to have a very productive international conference. We are also happy that quite a large number of researchers from Eastern European and Third World countries are able to participate in the Symposium in spite of their substantial difficulties in obtaining convertible currency. We gratefully acknowledge the financial support provided by various public institutions and private firms, in particular Deutsche Forschungsgemeinschaft, Deutscher Akademischer Austauschdienst and Gesellschaft von Freunden und Förderern der Rheinischen Friedrich-Wilhelms-Universität.

The structure of the meeting will be roughly the same as it was for the past symposia. For this meeting, however, we have for the first time organized 23 state-of-the-art tutorials. These are intended to be a combined plenary talk and comprehensive survey lecture, and are given by leading experts in the respective fields. We hope that you will enjoy these presentations and that you will profit from them. There will be four of these lectures (two parallel sessions) every day except on Monday when there will be three lectures and eight on Wednesday.

The schedule of the contributed and invited talks within a session was made in order to avoid conflicts with other talks on similar topics in parallel sessions. It does not indicate a ranking.

As a tradition of Mathematical Programming Symposia the ratio of participants to lectures is close to one. Due to the large

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problems with independent jobs. Maximum lateness is a more general optimality criterion than makespan. And so on. All that was required to produce the tabulation was to feed the computer all results in the form of known easy problems and known NP-hard problems (ignoring results that were clearly dominated by others), let the computer take account of the partial ordering, and let it churn out a properly annotated listing.

That afternoon at the Math Center, the group speculated on what the score would be: how many *'s, !'s and ?'s would the tabulation contain? A playful attempt was made to obtain an estimate by generating a few random chains in the partial order, with everyone testing his expertise to see how far up a chain he could prove easiness and how far down NP-hardness. (Lenstra has since made the generation of random chains part of one of his stock lectures, with a member of the audience throwing a die.)

The next inevitable suggestion someone made was: "Why not have the computer list the maximal easy and minimal hard problems, and the minimal and maximal open ones as well? Wouldn't that give us a clearer picture of the situation?"

A suitable program was forthwith written by Lageweg and an initial run was made. The results were startling, for the number of easily resolvable cases it revealed in the listings of minimal and maximal open problems. During the next few weeks Lageweg, Lawler and Lenstra knocked off many targets of opportunity. The number of question marks in the tabulation was considerably smaller when, on January 28, 1976, a handsomely bound volume was presented to Alexander [5].

During the past six years there have been many developments, and Alexander's volume is now thoroughly outdated. The most impressive progress has been made in the area of preemptive scheduling of parallel machines. An elegant algorithm due to Gonzalez and Sahni (for $Q|pmtn|C_{max}$, the problem of minimizing makespan in preemptive scheduling of uniform parallel machines) [3] spawned a whole host of derivative algorithms for related problems.

At the present time, the score for 4,536 problem types stands at 81% NP-hard, 9% easy and 10% open [7]. This particular split is an artifact of our classification system, but it is certainly true that several subareas have been pretty well cleaned up. For example, the status of almost all single machine problems is known. Though open problems are still occasionally resolved, it is safe to say that nearly all the cream has been skimmed.

The problems which remain are mostly rather difficult. It is possible that they are neither NP-hard nor easy, provided that $P \neq NP$ (which we believe). One of the frustrations of the theory is that there is no way of proving such a result at present. For those who might care to accept a challenge, we mention two classic open problems: (1) $P3|prec, p_j = 1|C_{max}$, the problem of minimizing makespan for unit-time jobs subject to arbitrary precedence constraints on three identical parallel machines: known to be easy for two machines and NP-hard for an arbitrary number of machines.
(2) $1||\Sigma T_j$, the problem of minimizing total tardiness on a single machine: known to admit of a pseudopolynomial algorithm, hence not NP-hard in the strong sense (unless $P = NP$). Is this problem easy or is it NP-hard in the ordinary sense?

A few words about the significance of NP-completeness theory are in order. It is not always true that polynomial algorithms are *good* and that problems that admit of such algorithms are *easy* to solve in practice. It is perhaps even less true that NP-hard problems are invariably *hard* in a practical sense. Yet there is enough correspondence with reality to make the notions of *easy* and *NP-hard* more than a polite fiction. Some NP-hard problems are *really hard* to solve. For example, no one has yet solved to optimality a certain notorious 10-machine 10-job job shop problem, small as this problem instance is. (The best published solution has a makespan of 972 [8]. Lageweg has found a solution of 935. The best known lower bound is 865.)

The primary usefulness of the concept of NP-hardness is the direction it gives to the algorithm designer. With knowledge that a problem is NP-hard, he can abandon any attempt to reformulate the problem as, say, a simple network flow problem or a graphic matching problem. Instead he can concentrate his energies on developing an efficient enumerative optimization method or a well-behaving approximation algorithm. It is in this way that NP-completeness theory has probably had more impact on combinatorial optimization than any other theoretical development of the past ten years. We were pleased to observe, during the NATO Advanced Study and Research Institute on Deterministic and Stochastic Scheduling (Durham, England, July 1981) [2], that the methodology carries over to computational questions about stochastic scheduling as well.

One of our hopes when we began [illegible] project was that we might be able to determine the boundary line between easy and NP-hard problems sufficiently closely that we could gain meaningful insight into the properties that make a scheduling problem of one type or the other. This we have been able to do to some extent. When dealing with a practical scheduling problem (which is invariably NP-hard), we found it increasingly easy to detect the particular features of the problem which were responsible for its computational intractability, since they would correspond to the crucial ingredients of an NP-hardness proof. These features then suggested certain relaxations that should be made to obtain lower bounds for a branch-and-bound procedure, or directions that could be taken in designing a heuristic.

Now to return to a discussion of the computer program and the benefits we have received from it. First, the program has provided an orderly form of record keeping for research results. Confusions and [illegible]sights have been greatly reduced. Seco[illegible], the program has helped us focus our research. Listings of minimal and maximal open problems have made it easy to choose the most interesting and important ones to work on. And finally, the automatic scorekeeping has been motivational and introduced a healthy competition into our work.

A frivolous idea which occurred to us was that the computer might be programmed to produce another type of score, namely the minimum number of open problems whose resolution would resolve all remaining open problems. Alas, we found that the calculation of this score is itself an NP-hard problem [6]. We have made no attempt to devise an algorithm for its solution.

We believe that computer programs similar to ours could be applied equally well to other well-structured areas of knowledge and research. Certainly allied areas of combinatorial optimization such as location theory and, more ambitiously, algorit[illegible] graph theory are candidates. Even the b[illegible]d area of mathematical programming might be susceptible, as well as inventory theory, queueing theory, or even organic chemistry.

It would not be difficult to create a

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sort of automated encyclopedia. Given such a system for the field of mathematical programming, the user could make queries of the form: "What is known about a problem with such-and-such objective function and so-and-so constraints?" The system might answer: "Nothing has been reported on this specific problem, but these results have been obtained for more general and more special cases. Moreover, the following computer codes are available . . ." The program would be knowledgeable of problem relationships which might be unknown to the user, even if their usefulness would be contingent on future theoretical developments. For example, it would know that maximization of a posynomial in bivalent variables is equivalent to the min-cut problem of network flow theory.

There are other types of question-answering facilities it would be useful to have. For example, for a book on scheduling theory we are writing, we should like to state a few simple rules that will enable the reader to comprehend the status of large subclasses of problems. It would be nice to be able to verify these rules by asking the system questions of the form: "Are there easy problems involving the nonpreemptive scheduling of parallel machines which do not have the objective of minimizing flowtime?" or "Are there any problems which are known to be NP-hard when preemption is permitted but easy when it is not?"

At some future date it may be possible to have computers search for problem transformations themselves. At this time, such an undertaking appears to be beyond the capabilities of artificial intelligence. Should this development come to pass, the computer would truly be an automated research assistant.

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Computer Codes for Selected Network Optimization Problems

The purpose of this note is to report on a collection of computer codes that are designed to handle certain network optimization problems that arise frequently in modeling and in practice. The selected codes have special relevance to transportation and distribution problems especially in the area of routing and scheduling. Since some of the problems frequently emerge as building blocks in more complex models, we believe that a collection of codes (in subroutine form) of this sort could be extremely useful to other network researchers.

Each algorithm coded is listed below in one of five categories. All codes are in FORTRAN and are user-oriented in nature. The description of each algorithm includes a complete specification of input and output characteristics and the computer environment of the subroutine. Moreover, along with each code is a brief directory that summarizes its purpose, applications, and performance characteristics. Our hope is that this will make the algorithms particularly accessible to the novice as well as the expert.

We do not claim that the codes represent the most efficient means of solving the related problems and, furthermore, we have made no special effort to fine-tune them. We do feel, however, that they provide easy-to-use and reasonably-effective tools for solving the selected network problems, especially when a major coding effort is not warranted. As such, we anticipate that this collection will be of benefit to a variety of applications-oriented users.

The collection of codes is available as "Listings and Documentation for Selected Network Optimization Computer Codes," Management Science and Statistics Working Paper No. 81-003, College of Business and Management, University of Maryland at College Park.

List of Network Optimization Algorithms Included

I. THE TRAVELING SALESMAN PROBLEM (TSP)
- a) Arbitrary Insertion TSP Heuristic - ABSRT
- b) Cheapest Insertion TSP Heuristic - CHSRT
- c) Farthest Insertion TSP Heuristic - FRSRTA
- d) Nearest Neighbor TSP Heuristic - NBOS
- e) Nearest Insertion TSP Heuristic - NRSRT

II. VARIATIONS OF THE TRAVELING SALESMAN PROBLEM
- a) Modified Clark-Wright Algorithm for Vehicle Routing - CRVRP
- b) Traveling Salesman Alorithm for Directed Networks - DTSP
- c) Time-Constrained Traveling Salesman Algorithm - TCTSP
- d) Traveling Purchaser Algorithm - TPP

III. SHORTEST PATH PROBLEMS
- a) Bellman's Algorithm - BELL
- b) Dijkstra's Algorithm - DIJKST
- c) Floyd's Algorithm - FLOYD
- d) Modified Floyd's Algorithm - F3
- e) Pape's Algorithm - UPAPE

IV. THE MINIMAL SPANNING TREE PROBLEM
- a) Minimum Spanning Tree Algorithm - MINSPT
- b) Prim's Minimum Spanning Tree Algorithm - PRIM

V. NETWORK FLOWS
- a) Maximum Flow Algorithm - NETFLOW
- b) Dilworth's Chain Decomposition Algorithm - DILS

—A. Assad, B. Golden, L. Bodin, M. Ball and R. Dahl

CALENDAR

Maintained by the Mathematical Programming Society (MPS)

This Calendar lists meetings specializing in mathematical programming or one of its subfields in the general area of optimization and applications, whether or not the Society is involved in the meeting. (These meetings are not necessarily "open".) Any one knowing of a forthcoming meeting not listed here is urged to inform the Vice Chairman of the Society, Dr. Philip Wolfe, IBM Research 33-221, POB 218, Yorktown Heights, NY 10598, U.S.A; Telephone 914-945-1642, Telex 137456.

Some of these meetings are sponsored by the Society as part of its world-wide support of activity in mathematical programming. Under certain guidelines the Society can offer publicity, mailing lists and labels, and the loan of money to the organizers of a qualified meeting. For further information address the Chairman of the Executive Committee, Dr. A. C. Williams, Mobil Corporation, 150 East 42d Street, New York, New York 10017, U.S.A.; Telephone 212-883-7678.

Substantial portions of meetings of other societies such as SIAM, TIMS, and the many national OR societies are devoted to mathematical programming, and their schedules should be consulted.

1982

August 23-28: Eleventh International Symposium on Mathematical Programming in Bonn, Federal Republic of Germany. Contact: Institut für Ökonometrie und Operations Research Universität Bonn, Nassestraße 2, 5300 Bonn 1, Federal Republic of Germany; Telex 886657 unibo b, Telephone (02221) 739285. Official triennial meeting of the MPS. (Note: The International Congress of Mathematicians will be held August 11-19 in Warsaw, Poland.)

October 25-27: Sparse Matrix Symposium 1982, Fairfield Glade, Tennessee, U.S.A. The Symposium will address the construction and analysis of algorithms and mathematical software for sparse matrix calculations and associated applications, one of which is 'Optimization'. Abstract deadline 1 July 1982. Contact: Robert C. Ward, Union Carbide Corporation, MSRD, Computer Sciences, P. O. Box Y, Bldg. 9704-1, Oak Ridge, Tennessee 37380, U.S.A.; telephone 615-574-3131.

October 20-21: Third Mathematical Programming Symposium Japan, Tokyo, Japan. Recent Advances in Mathematical Programming, Mathematical Programming Software, and Applications. Contact: Professor Masao Iri (Chairman, Organizing Committee), University of Tokyo, Bunkyo-ku, Tokyo, Japan 113, or Professor Kaoru Tone (Chairman, Program Committee), Graduate School for Policy Science, Saitama University, Urawa, Saitama 338, Japan.

1983

July 11-15: 3d IFAC/IFORS Symposium "Large Scale Systems: Theory and Applications", Warsaw. Deadline for abstracts, 15 February 1982. Contact: Dr. Z. Nahorski, 3d IFAC/IFORS LSSTA, Systems Research Institute, Polish Academy of Sciences, ul. Newelska 6, 01-447 Warszawa, Poland; Telex 812397 ibs pl, Telephones 364103, 368150.

July 25-29: 11th IFIP Conference on System Modelling and Optimization, Copenhagen, Denmark. Deadline for abstracts, 31 December 1982. Contact: Professor P. Thoft-Christensen, Institute of Building Technology and Structural Engineering, Aalborg University Center, P.O. Box 159, DK-9100 Aalborg, Denmark.

CONFERENCE NOTES

NEW YORK

The "Friends of Optimization" was a loosely organized group of mathematical programmers that held twenty-four meetings in New York City, 1971-76. **Donald Goldfarb** (Department of Industrial Engineering and Operations Research, Columbia University, New York, NY 10027, U.S.A.) has reactivated this group.

As he writes, "There are several good reasons for doing so. First, many active researchers and users of optimization have moved to the New York area since the last FPO meeting and several of them have expressed a strong interest in meeting informally to discuss current research. Second, the FOP meetings that were held from 1971 through 1976 were quite successful in helping mathematical programmers in the New York area keep in contact with one another and keep abreast of advances in the field. Third, there have been a number of new and interesting developments in mathematical programming since 1976. . ."

The first in the new series of meetings was held on February 4, 1982, at the City University Graduate Center in Manhattan. **W.C. Davidon** of Harverford College spoke on "Conjugate Directions for Conics." **Jorge Nocedal** of the Courant Institute of Mathematical Sciences (New York University) followed with another view of the same topic. Other recent meetings were Friday, March 5, **R. Dembo**: "Truncated Newton Methods;" Thursday, April 1, **R. Bland**: "Minty Coloring and Linear Programming Duality;" Friday, May 7, **M. Grigoriadis**: "Primal, Dual, and Parametric Network Simplex Algorithms." Write Professor Goldfarb to be included in the mailing list of announcements.

The Mathematical Programming Society wants to encourage the development of local groups of this kind. If you know of such an existing group, or could use the Society's assistance in forming one, please contact the Chairman of the executive Committee: Dr. A.C. Williams, Mobil Corporation, 150 East 42nd Street, New York, New York 10017, U.S.A.

—Philip Wolfe

Linköping

A Nordic Symposium on Linear Complementarity Problems and Related Areas was held at the Institute of Technology, Linköping, Sweden.

In the list of participants, holding approximately 60 names, one could find names like **A.W. Tucker**, **H. Kuhn**, **V. Klee** and several others from the U.S., many from Europe and even one each from the USSR and China.

Besides the sessions on complementary pivoting, variational inequalities and fixed point theory, there were sessions on convexity and duality and on linear and quadratic programming.

Upon request, the organizer **Dr. Per Smeds** at the department of Mathematics will send a technical report with "Extended Abstracts" of the talks.

The conference was sponsored by The National Swedish Board of Technical Development (STU), Nordiska Forskarkurser and The Swedish Institute of Applied Mathematics.

—Johan Philip

Montreal

The Optimization Days 1982 were held at the Ecole des Hautes Etudes Commerciales (Business School) on the campus of the Université de Montréal, May 13 and 14, 1982. It was the tenth anniversary of this annual meeting that grew from a local meeting to one including speakers from all parts of Canada, United States, Latin America, and Europe. There were more than 185 participants, and more than 90 papers were presented. Four plenary sessions were also organized with the following speakers: **Austin Blaquiere, Jean-Louis Goffin, Tom Magnanti,** and **M.K. Sain.** This event is sponsored by IEEE Control Systems Society, Association Canadienne-Francaise pour l'Avancement des sciences, SIAM, Mathematical Programming Society, and Société Canadienne de Mathématiques Appliquées. We gratefully acknowledge the financial support of the Ministére de l'Education du Québec, the Natural Sciences and Engineering Research Council of Canada, and the Social Sciences and Humanities Research Council of Canada.

Next year the Optimization Days 1983 will be held at the Ecole Polytechnique (Engineering School) on the campus of the Université de Montréal, May 1983.

—Jacques A. Ferland
President, Optimization Days 1982

WELCOME TO BONN

number of invited and contributed papers and the 23 plenary state-of-the-art tutorials, we are forced to start very early (8:15 am) and work very hard until 6:15 pm. We hope that the boat trip to Linz up the river Rhine and back will provide the necessary relief from the stress of the days before.

The concert on Tuesday evening will also give you a chance to relax while listening to the Baroque Ensemble of the Collegium Musicum of the University of Bonn, presenting Gabrieli, Frescobaldi, Fasch, Handel, Boismortier and Bach.

During the buffet dinner at the reception in the Rheinisches Landesmuseum on Monday evening you will have the opportunity of meeting all your friends within the Mathematical Programming community and enjoying the outstanding exhibits of the museum.

All events of the meeting (except the reception on Monday) will take place in the main building of the University of Bonn, which is the former residential palace and the hunting lodge of the archbishop of Cologne.

We recommend that you take the opportunity to discover some of the beautiful places Bonn has to offer. Bonn is a 1913-year-old city with an eventful history. The social program will guide you to some of the most interesting places.

All members of the organizing committee will be happy to answer your questions and help you to overcome technical problems. Please do not hesitate to contact them (you may identify the members of the organizing staff by a red dot on the name tag).

Achim Bachem
Martin Grötschel
Co-Chairmen
Organizing Committee

Bernhard Korte
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OPTIMA

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Technical Reports & Working Papers

STANFORD UNIVERSITY
Systems Optimization Laboratory
Department of Operations Research
Stanford, CA 94305

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M.A. Hanscom, J.-J. Strodist, Nguyen Van Hien, "*Une approche de Type Gradient- Réduit en Optimization Non-Différentiable Pour l'ordonnancment á Moyen Terme de La Production d'énergie électrique dans un Systéme de Production Mixte*," Rapport No. 2427.

UNIVERSITY OF FLORIDA
Department of Industrial and Systems Engineering
303 Weil Hall
Gainesville, FL 32611

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ERASMUS UNIVERSITY ROTTERDAM
Econometric Institute
P.O. Box 1738
3000 DR Rotterdam
The Netherlands

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UNIVERSITY OF MARYLAND
College of Business and Management
College Park, Maryland 20742

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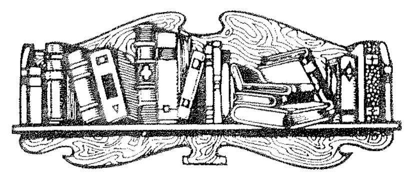

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THE MATHEMATICAL PROGRAMMING SOCIETY

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Gallimaufry

Thomas L. Magnanti (M.I.T.) will be the new editor of Operations Research, effective January 1983 . . . **Ronald Rardin** (Georgia Tech) will visit Purdue during 1982-83. . . **Mokhtar Bazaraa** (Georgia Tech) will be on leave in 1982-83 at Burnham Van Lines . . . **Don Goldfarb**, formerly of City College of New York, has accepted a position as Professor of Industrial Engineering and Operations Research at Columbia University starting July 1, 1982 . . . **Jack Edmonds** (Waterloo) will visit Cornell during 1982-83 . . . **L. Lovasz** (Szeged) visited Cornell in May as Andrew D. White Visiting Professor and will return for one to two weeks in each of the next five years . . . In May, **Herbert Robbins** (Columbia) gave the second Annual Lecture Series honoring **D. R. Fulkerson** at Cornell . . . **Saul I. Gass** (Maryland) has communicated news of the death of **Dr. Walter W. Jacobs**, formerly associated with USAF Project SCOOP which originated the theory of linear programming and developed its first applications. Dr. Jacobs, in particular, formulated the caterer's problem (jet engine replacement model) and the parametric objective function problem.

Deadline for the next issue of OPTIMA is October 1, 1982.

NEW OFFICERS

Professor **Alex Orden** (Chicago) been elected to the Chairmanship of Society for the three year period beginning August 1983. **A. C. Williams** (Mobil) will be Treasurer for the same period. New at-large Council members are **E. M. L. Beale** (SCICOM), **Jean-Louis Goffin** (McGill), **Donald Goldfarb** (Columbia), and **J. K. Lenstra** (Mathematish Centrum). Council terms will begin August, 1982, at the Bonn Symposium, and are for three years.

STUDENT MEMBERS

By recent action of the MPS Council, student memberships are now available. Dues for students are one-half the regular membership dues, and the student membership includes all rights and privileges of regular membership except voting rights. Included are subscription to the Journal and to Optima. An application form is included in this issue. Applications (for students only) must be sent to **John Mulvey**, Chairman of the Membership Committee, at the address given.

OPTIMA
303 Weil Hall
College of Engineering
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FIRST CLASS MAIL

This public document was promulgated at a cost of $426.15 or $0.61 per copy to inform researchers in mathematical programming of recent research results.

THE MATHEMATICAL PROGRAMMING SOCIETY

Results of the 1982 Questionnaire

The 1982 Questionnaire was published in the issue of OPTIMA dated March 1982. By June, 1982, members had returned 49, which are tallied below.

1. Normally the 1985 International Symposium on Mathematical Programming would be held in North America. There has been some discussion of holding it in Japan, but there is concern about the travel cost for many of our members. Would you plan to attend the Symposium if it were held in --

Japan:	Probably yes: 25	Probably no: 22
North America:	Probably yes: 47	Probably no: 0

2. The activities of our Society are expanding and we would like to invite interested members to become more active. Please check those areas in which you might like to participate: Publications Committee, Membership Committee, Committee on Algorithms, Establish new activities, Editorial activities, Administrative, and Other.

   Nineteen members responded of this question and we appreciate the interest expressed by these individuals. Their offers of service have been passed on to the appropriate Officers of the Society for action.

3. List subjects, if any, whose emphasis in the journal you would like changed.

   Give more emphasis to:

   Applications (9), Computation (5), Stable Numerical Methods (2), Software (2), Nonlinear Programming (2). One mention each for: Theory, Combinatorics, Book Reviews, Short Communications, Surveys, Global Optimization, Game Theory.

   Give less emphasis to:

   Theory (4), Unsupported Algorithms (2), Optimality Conditions (1), Graph Theory (1).

4. If you have submitted an article to Mathematical Programming in the last two years, how did you find the response time?

   Excellent: 2 Good: 5 Fair: 8 Poor: 8

5. Do you think the Society should sponsor a new journal devoted exclusively to applications and systems?

   20 - Yes 25 - No

   Assuming reasonable cost, would you subscribe to it?

   27 - Yes 12 - No

6. What features would you like to see added to OPTIMA?

   Software News (4), New Book List (3), Problem Column (2), Letters to Editor (1), Employment Information (1), Contents of Relevant Journals (1), Applications News (1). (Eight members commented that OPTIMA was doing a great job.)

-- List here any services or activities that the Society is not providing that you would like to have, and any other comments:

Information about the winners of the Dantzig & Fulkerson prize and the relevance of their work either in OPTIMA or the JOURNAL, algorithm distribution service, package deal for the JOURNAL and the STUDIES.

Compiled June 15, 1982
By the Executive Committee