PASCAL USERS GROUP

Pascal News

NUMBER 17

COMMUNICATIONS ABOUT THE PROGRAMMING LANGUAGE PASCAL BY PASCALERS

SEPTEMBER, 1980

POLICY: PASCAL NEWS (15-Sep-80)

* Pascal News is the official but informal publication of the User's Group.

* Pascal News contains all we (the editors) know about Pascal; we use it as the vehicle to answer all inquiries because our physical energy and resources for answering individual requests are finite. As PUG grows, we unfortunately succumb to the reality of:

1. Having to insist that people who need to know "about Pascal" join PUG and read Pascal News - that is why we spend time to produce it!

2. Refusing to return phone calls or answer letters full of questions - we will pass the questions on to the readership of Pascal News. Please understand what the collective effect of individual inquiries has at the "concentrators" (our phones and mailboxes). We are trying honestly to say: "We cannot promise more that we can do."

* Pascal News is produced 3 or 4 times during a year; usually in March, June, September, and December.

* ALL THE NEWS THAT'S FIT, WE PRINT. Please send material (brevity is a virtue) for Pascal News single-spaced and camera-ready (use dark ribbon and 18.5 cm lines!)

* Remember: ALL LETTERS TO US WILL BE PRINTED UNLESS THEY CONTAIN A REQUEST TO THE CONTRARY.

* Pascal News is divided into flexible sections:

POLICY - explains the way we do things (ALL-PURPOSE COUPON, etc.)

EDITOR'S CONTRIBUTION - passes along the opinion and point of view of the editor together with changes in the mechanics of PUG operation, etc.

HERE AND THERE WITH PASCAL - presents news from people, conference announcements and reports, new books and articles (including reviews), notices of Pascal in the news, history, membership rosters, etc.

APPLICATIONS - presents and documents source programs written in Pascal for various algorithms, and software tools for a Pascal environment; news of significant applications programs. Also critiques regarding program/algorithm certification, performance, standards conformance, style, output convenience, and general design.

ARTICLES - contains formal, submitted contributions (such as Pascal philosophy, use of Pascal as a teaching tool, use of Pascal at different computer installations, how to promote Pascal, etc.).

OPEN FORUM FOR MEMBERS - contains short, informal correspondence among members which is of interest to the readership of Pascal News.

IMPLEMENTATION NOTES - reports news of Pascal implementations: contacts for maintainers, implementors, distributors, and documentors of various implementations as well as where to send bug reports. Qualitative and quantitative descriptions and comparisons of various implementations are publicized. Sections contain information about Portable Pascals, Pascal Variants, Feature-Implementation Notes, and Machine-Dependent Implementations.

- - - - - - ALL-PURPOSE COUPON - - - - - - (15-Sep-80)

Pascal User's Group, c/o Rick Shaw
P.O. Box 888524
Atlanta, Georgia 30338 USA

NOTE

- Membership fee and All Purpose Coupon is sent to your Regional Representative.
- SEE THE POLICY SECTION ON THE REVERSE SIDE FOR PRICES AND ALTERNATE ADDRESS if you are located in the European or Australasian Regions.
- Membership and Renewal are the same price.
- Note the discounts below, for multi-year subscription and renewal.
- The U. S. Postal Service does not forward Pascal News.

- -

[ ] Enter me as a new member for:

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[ ] 1 year	$10.	£6.	A$ 8.
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[ ] Send Back Issue(s) !________________________________!

[ ] My new address/phone is listed below

[ ] Enclosed please find a contribution, idea, article or opinion which is submitted for publication in the Pascal News.

[ ] Comments:____

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ENCLOSED PLEASE FIND: $ / A$ / £ _____._____

CHECK no. ___________

NAME ____

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JOINING PASCAL USER'S GROUP?

- Membership is open to anyone: Particularly the Pascal user, teacher, maintainer, implementor, distributor, or just plain fan.
- Please enclose the proper prepayment (check payable to "Pascal User's Group"); we will not bill you.
- Please do not send us purchase orders; we cannot endure the paper work!
- When you join PUG any time within a year: January 1 to December 31, you will receive all issues of Pascal News for that year.
- We produce Pascal News as a means toward the end of promoting Pascal and communicating news of events surrounding Pascal to persons interested in Pascal. We are simply interested in the news ourselves and prefer to share it through Pascal News. We desire to minimize paperwork, because we have other work to do.

- American Region (North and South America): Send $10.00 per year to the address on the reverse side. International telephone: 1-404-252-2600.
- European Region (Europe, North Africa, Western and Central Asia): Join through PUG (UK). Send £5.00 per year to: Pascal Users Group, c/o Computer Studies Group, Mathematics Department, The University, Southampton S09 5NH, United Kingdom; or pay by direct transfer into our Post Giro account (28 513 4000); International telephone: 44-703-559122 x700.
- Australasian Region (Australia, East Asia - incl. Japan): PUG(AUS). Send $A10.00 per year to: Pascal Users Group, c/o Arthur Sale, Department of Information Science, University of Tasmania, Box 252C GPO, Hobart, Tasmania 7001, Australia. International telephone: 61-02-23 0561 x435

PUG(USA) produces Pascal News and keeps all mailing addresses on a common list. Regional representatives collect memberships from their regions as a service, and they reprint and distribute Pascal News using a proof copy and mailing labels sent from PUG(USA). Persons in the Australasian and European Regions must join through their regional representatives. People in other places can join through PUG(USA).

RENEWING?

- Please renew early (before November and please write us a line or two to tell us what you are doing with Pascal, and tell us what you think of PUG and Pascal News. Renewing for more than one year saves us time.

ORDERING BACK ISSUES OR EXTRA ISSUES?

- Our unusual policy of automatically sending all issues of Pascal News to anyone who joins within a year means that we eliminate many requests for backissues ahead of time, and we don't have to reprint important information in every issue--especially about Pascal implementations!
- Issues 1 .. 8 (January, 1974 - May 1977) are out of print. (A few copies of issue 8 remain at PUG(UK) available for £2 each.)
- Issues 9 .. 12 (September, 1977 - June, 1978) are available from PUG(USA) all for $15.00 and from PUG(AUS) all for $A15.00
- Issues 13 .. 16 are available from PUG(UK) all for £10; from PUG(AUS) all for $A15.00; and from PUG(USA) all for $15.00.
- Extra single copies of new issues (current academic year) are: $5.00 each - PUG(USA); £3 each - PUG(UK); and $A5.00 each - PUG(AUS).

SENDING MATERIAL FOR PUBLICATION?

- Your experiences with Pascal (teaching and otherwise), ideas, letters, opinions, notices, news, articles, conference announcements, reports, implementation information, applications, etc. are welcome. Please send material single-spaced and in camera-ready (use a dark ribbon and lines 18.5 cm. wide) form.
- All letters will be printed unless they contain a request to the contrary.

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Contributors to this issue (#19) were:

EDITOR	Rick Shaw
Here & There	John Eisenberg
Books & Articles	Rich Stevens
Applications	Rich Cichelli, Andy Mickel
Standards	Jim Miner, Tony Addyman
Implementation Notes	Bob Dietrich, Greg Marshall
Administration	Moe Ford, Kathy Ford, Jennie Sinclair

APPLICATION FOR LICENSE TO USE VALIDATION SUITE FOR PASCAL

Name and address of requestor: ______________________
(Company name if requestor is a company) ______________________
____

Phone Number: ______________________

Name and address to which information should ______________________
be addressed (Write "as above" if the same) ______________________
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In making this application, which should be signed by a responsible person in the case of a company, the requestor agrees that:

a) The Validation Suite is recognized as being the copyrighted, proprietary property of R. A. Freak and A.H.J. Sale, and

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P.O. Box 598
Easton, Pa. 18042
USA
Attn: R.J. Cichelli

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Select block size in logical records per block.
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( ) RSX-IAS PIP Format
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Office use only

Signed ______________________
Date ______________________

Richard J. Cichelli
On behalf of A.H.J. Sale & R.A. Freak

Editor's Contribution

SO WHATS NEW

Well lots! We have extended the subscriptions of all members by 6 months. The effect of this change is that we align the subscription year to the calendar year instead of an academic year. So now, it should be easier to know when your subscription expires. Note that our policy of sending all back issues for the year has not changed. Therefore the year marked on the labels is the year through which your subscription is effective. Remember, now subscriptions expire on December 31.

Also, as you can see if you have read the new APC, the price of Pascal News is going up. Sorry. We resisted as long as we could. But note that we offer a good price break for multiple year subscriptions. Subscribing for more than one year saves us a great deal of work. Please, please help us save paper work! The new prices will go into effect 1-January-80. Until then, we will accept renewals and subscriptions at the old price. So if you have not yet renewed, do it now, while the price is low low low! We also have a new address! (note the new APC again) You may recognize it as the return address for issues 17 and 18. The address is simple and does not include a company name. (yes the box number really does have six digits and three are 8's) I hope the new address mollifies those people who worried about vendor bias. By the way, my employer provides no support for Pascal Users Group, in any way shape or form. Which leads me to the next subject.

HELP -- I'M BEGGING

Pascal Users Group needs its own computer. It has become a necessity, to be able to maintain our ever increasing data base, and do all of our record keeping. If your company can offer any type of a product for our use either as a gift, for long term use, or at a substantial discount we would like to hear from you. We are not very ambitious. Our thoughts are to secure a micro processor, a terminal, a small line printer, a hard disk, and a set of floppys. Small potatoes! Right? The system must be in place by December in order for us to be on time for the next issue. So, please, won't you call right away. (Jerry Lewis, eat your heart out) I have exausted all my favors in Atlanta.

CHANGE OF ADDRESS -- A REAL PROBLEM

I just can not believe how many people change there address and do not inform Pascal News! The expense is phenominal. Bulk mail is not forwardable by the post office. It costs

$.15 to send a change of address card to us, and $1.43 just in return postage if you do not. That does not include the postage to get it to you at your new address. This is a tremendous expense to PUG when 142 people "just forgot". Please help us get Pascal News to you on time. OK? So if you suspect we may have your back copies, send us a stamped self-addressed envelope with a note telling us which issues you have not recieved and we will give you your copies or a new set, no questions asked. Simple, right?

THE GOOD STUFF -- WHAT'S IN THIS ISSUE

As usual, we have a gigantic "HERE AND THERE" section this issue. it is chock full of feedback from the readers. If you put anything on the "comments" section of the APC or sent anything to me or John that was not a letter, it ends up here. So keep up the notes and comments.

I would also like to call your attention to the section on "BOOKS AND ARTICLES" if you are looking for some side reading on Pascal there are over 300 citings. Wow! And Rich has collected together a very complete list of the text books available on subject of Pascal. If your favorite is not there please drop us a line on an APC. OK?

Since Andy Mickel has a few spare moments lately, he has contributed 3 fine tidbits of information. The first is a thumbnail review of all the back issues of Pascal News (1..16). Second, he has rolled up the 78-79 finances. And third, is a summary of all the machines represented by the PUG membership, derived from the old APCs. Very interesting.

The "APPLICATIONS" section contains Wirth's Pascal-S, the subset Pascal compiler. It has been around for a while but many new users have never seen it. We also have included a LISP interpreter, for those who need the power and flexibility?! Enjoy.

The "ARTICLES" are really great too. Both show a solid approach to making a good thing better.

Jim Miner reports on the standards turmoil. The facts are laid out, and testimony from both sides is presented. You be the judge. And Let us know what you think.

And finally "IMPLEMENTATION NOTES". Fourty pages of them. Note IBM's offical entry. 'Nuff said.

Hope you like it.

Rick

Here and There With Pascal

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Peter C. Akwai, IBM Kst. 3787, Postfach 33 09,6000 Frankfurt/M1 West Germany: "We are willing to assume some of the unassigned Pascal Newsletter work caused by Andy Mickel's retirement. Let us know what we can do to help. Pasteup, Selectric composer facilities available, some graphics/cartooning, etc." (*79/05/05*)

Haim Avni, Givat Brenner, Israel 60948: "We are a rather new software group, very keen Pascalers and eager to have this line of communication with other Pascal users." (*80/05/09*)

David P. Babcock, 508 First Street, Alamosa, CO 81101: "Disappointed to note address is now DEC. Please try to maintain at least a semblance of independence in any case." (*80/01/20*)

John W. Baxter, 1830 Avenida del Mundo, Apt. 1710, Coronado, CA 92118 is using Pascal on an Apple at home, and also uses "an offspring of PASCAL -- called NCR language -- in my work at NCR Corp." (*79/12/28*)

Hank Becker, Yourdon - Software Products Group, 1133 Ave. of the Americas, New York, NY 10036: "We will be distributing a Concurrent Pascal (compiler is transportable) with P-codes to run on 8080/8085/Z80 and eventually other [micros]." (*80/02/23*)

Paul J. Beckmann, 1907 Bohland, St. Paul, MN 55116: "PN outstanding! Thanks to Andy and the U of M Pascal Think Tank. Good luck to you, Rick, in Georgia." (*80/02/23*)

Norman Belssner, 9616 Thunderbird Drive, San Ramon, CA 94583 is interested in implementations of Pascal on TRS-80. (*80/01/05*)

K.S. Bhaskar, 22828 76th Ave. W. Apt. #33, Edmonds, WA 98020 is using the NBS Pascal Compiler on a PDP 11/70 to generate code which is executed on a stand-alone LSI-11 for real-time applications. (*80/01/21*)

K. Brauer, Universitaet Onasbrueck, 45 Onasbrueck, Postfach 4469 uses and teaches Pascal at University, and is very much iterested in getting further issues of the newsletter. (*80/01/03*)

Frank M. Brewster, 1 North Vista Ave., Bradford, PA 16701: "If you live up to Andy's standards, you'll deserve the same huge thanks we owe to him. Goiod luck." (*80/02/06*)

Frank Bush, Tennessee Tech. Univ., Box 5071, Cookeville, TN 38501 has just started using UCSD B-6700 Pascal. (*80/05/06*)

R. Bush, P.O. Box F, North Bend, OR 97459: "yeah 'Applications', Validation Suite et al. Kudos to AM for service...is nasty K. Bowles really that bad?" (*80/01/23*)

Larry H. Buss, 101 South U St., Apt,. 1, Lompoc, CA 93436: "I have a system running under standard CP/M with 48K.... I would like to examine the latest Pascal documentation. It seems that there are so many different versions of Pascal out. Is the standard Pascal from UCSD the best one?" (*80/01/17*)

Robert Caldwell, Scientific/Humanistic Interfaces, 2939 Governor Dr., San Diego, CA 92122: "Superb job - hang in there!" (*80/01/21*)

Dan Cantley, 3423 Carpenter Rd. Lot 10, Ypsilanti, MI 48197: "Just found the Pascal News - it's GREAT. Learned Pascal six months ago...our Accounting Department wanted an A/R package - our system didn't have the time or space - so I wrote the A/R package on our own micro - stuck it in Accounting Department. They love the package, and I love PASCAL." (*80/01/20*)

Chip Chapin, 3960 La Jolla Village Dr., La Jolla, CA 92037: "Should have joined long ago - have worked with UCSD Pascal project for 3 years." (*80/01/02*)

Les Cline, 1235 Wildwood Ave. #361, Sunnyvale, CA 94086: "I know not what others say, but as for me, give me Pascal, or give me Assembler!!" (*80/05/06*)

Roger A. Collins, 1653 Olmeda St., Encinitas, CA 92024: "I have found Pascal News very informative and helpful. Brought up an interpreter (* on a Perkin-Elmer 8/32 *) but found it unworkable in our environment, am now looking for a compiler." (*80/01/23*)

Stan Crouch, Technicon Medical Information Systems Corp., 3255-1 Scott Blvd., Santa Clara, CA 95051: "I am doing a study on the feasibility of converting some on-line programs to Pascal. I need to know whether or not Pascal programs can be made re- entrant and what is required in the operating system. Also, if you have any information on ADA capabilities I would appreciate any input in that area." (*80/04/08*)

Jeff Davis, 1515-J Tivoli Court, Raleigh, NC 27604 belongs to a local Apple users group that has started a Pascal Special Interest Group with good response. (*80/02/06*)

Tony DiCenzo, Digital Equipment, MR1-1/M40, Marlboro, MA 01752: "Good luck Rick - I'm sure this publication will flourish in your capable hands." (*80/02/03*)

George B. Diamond, Diamond Aerosol Corporation, R.D. #1, Glen Gardner, NJ 08826: "If we had this kind of effort in other fields we would not be a 3rd rate power." (*80/01/23*)

John Dickinson, Dept. of Elec. Engr., Univ. of Idaho, Moscow, Idaho 83843 is running Pascal on an IBM 370/145 and an HP1000 model 40. (*80/04/01*)

M. F. Doore, 1015 E. 10th St., Long Beach, CA 90813 is a Pascal Watcher in Electrical Engineering hoping to be the owner of a Western Digitial P Machine soon. (*80/03/31*)

Donald L. Dunstan, Cogitronics Corporation, 5470 N.W. Innisbrook Place, Portland, OR 97229: "Cogitronics develops software for microprocessor development systems. Currently we are working with a GenRad/Futuredata 8085 development systm and have generated a Pascal compiler for this system." (*80/01/23*)

Hank Feeser, 644B Washington Ave., Ft. Lawton, Seattle, WA 98199 owns an Apple II with Pascal and would greatly appreciate "any additional information on the implementation of Pascal on the Apple II". (*80/01/23*)

William A. Freberg, Computer Sciences Corporation, 2753 Highland Dr., Las Vegas, NV 89109: "Implementing Pascal 6000 from Zurich on CDC 6400 owned by Department of Energy at Las Vegas NV (NOS/BE operating system)." (*80/05/06*)

Edward R. Friedman, CIMS/New York Univ., 251 Mercer Street, New York, NY 10012: "Pascal is currently being used in courses devoted to programming languages. PROSE is also popular among researchers." Versions in use are Pascal 6000 Release 3 and Pascal from Sweden. (*80/01/23*)

Stuart H. Gage, Department of Entomology, Michigan State Univ., East Lansing, MI 48824 is "currently running UCSD Pascal on a Terak 8510/a and a CRDS MF-211, along with CDC Pascal on a Cyber 750/175. Our applications deal with delivery of agricultural information using microcomputer networks with an emphasis on graphics." (*80/01/23*)

Stephen Gerke, 1646 Parkcrest Cir. #301, Reston, VA 22090 says we should "consider publishing smaller but more regular PNs. Validation reports are very helpful." (*80/05/05*)

Pete Gifford, Allegheny College, Meadville, PA 16335 is running Pascal on an IBM 4331. (*79/12/26*)

Paul J. Gillian, P.O. Box 2202 C.S., Pullman, WA 99163: "finally got my computer (a Western Digital Pascal micro-Engine) and it's great!" (*80/01/23*)

Thomas Giventer, 127 Linden Ave., Ithaca, NY 14850: "You might be interested to know that the latest version of Ithaca Intersystems'...Pascal/Z now runs under CP/M (instead of K2) and supports real numbers and pointer variables.... See Byte, Jan. '80, page 14." (*80/01/23*)

R. Steven Glanville, Silicon Valley Software, Inc., 1531 Sandpiper Ct., Sunnyvale, CA 94087 is currently implementing an MC68000 Pascal compiler (*80/03/04*)

Steven K. Harr, Ohio State University, University Hospitals, 410 W. 10th Avenue, Columbus, OH 43210: "We are currently in the process of evaluating PASCAL compilers for use at our installation. We are running VS2 Release 1.7J on an IBM 370 Model 158J with 1.5 Mbytes of memory.... Any literature you may have concerning PASCAL compilers for IBM 370 computers would be extremely helpful to us at this point." (*80/01/16*)

Michael E. Harris, 407 W. Calhoun #17, Springfield, IL 62702: "I heartily agree with the PUG direction. I hope to be installing PASCAL on my Z-80 S100 system later this year. The main thing that I would like to see happen relative to PASCAL would be the establishment of an IBM/AMDAHL 370/3033/470 vendor supported standardized version of the language. Anybody out there have a Sperry-Univac/Varian V77-600 PASCAL that an individual could afford?"

Sassan Hazeghi, P.O. Box 4526, Stanford, CA 94305:"How about setting up a Pascal Program Library (a la SHARE)?" (*80/04/01*)

Thomas Hickey, 295 Garden Rd., Columbus, OH 43214:"Enjoy Pascal News very much. Have brought up Brinch-Hansen's Sequential on (*Xerox*) Sigma-9: limited implementation & very slow!" (*80/04/01*)

Jean Philippe Hilsz, 77 rue Vergniaud, 75013 Paris, France would like to know who supplies PASCAL compilers for Interdata 8/32, Interdata 8/16, Perkin Elmer DS 3220 and 3240. (*80/01/23*)

William T. Hole, M.D., 260 Collingwood, San Francisco, CA 94114 has Pascal/M and is hoping to "unleash the power of Pascal on my massive behavioral research observation files, which deal with premature babies in an intensive care nursery." (*80/04/23*)

Kenneth R. Jacobs, 10112 Ashwood Dr., Kensington, Maryland 20795 is using Pascal on a DEC-10 and Xitan (Z-80) (*79/02/13*)

Steve Jay, Computer Center, University of Arizona, Tucson, AZ 85721: "I am manager of software for the University's Computer Center. We provide PASCAL for use by any of our customers (* on a CDC Cyber 175 and a DEC-10 *). So far, they seem happy with it." (*80/01/21*)

R. L. Jenkins, Hartman Technica, #612-815-1st St. S W, Calgary, Alberta, Canada T2P 1N3: "We are particularly interested in PASCAL for microprocessors. As an electronics design consultancy we produce a lot of microprocessor machine code, and would prefer to leave this uninspiring task to a compiler." (*80/02/14*)

Mort Jonas,P.O. Box 390874, Miami Beach, FL 33139: "I've been using Pascal on the Apple II, and would be most interested in seeing how it would do on the validation suite, though I'm afraid I don't have time to do it myself." (*80/01/23*)

Berneta Kipp, 2206 NE 197th Place #D, Seattle, WA, 98155: "I am a programmer for Boeing writing my first PASCAL program to update a Boeing cost accounting data entry system." (*80/01/20*)

Les Kitchen, Computer Science Center, University of Maryland, College Park, MD 20742: "We're using National Bureau of Standards compiler (PDP-11/Unix), Naval Undersea Lab compiler and University of Wisconsin compiler (both

Univac 1108,1100/40) for computer vision research and for teaching programming." (*80/04/03*)

Richard W. Kreutzer, 644 Elizabeth St., Salt Lake City, UT 84102: "I would like to see updates/corrections to the Pascal validation suite published regularly. I think what you are doing is great." (*80/01/23*)

Peter Kugel, Fulton Hall, Computer Science Department, Boston Colege, Chestnut Hill, MA 02167: "I like Pascal News. (This validation issue is fiendish. Compliment, not insult.) I use Pascal for teaching. Why do I keep hearing so much about Tasmania?" (*80/05/06*)

B. Kumar, 420 Persian Dr., Sunnyvale, CA 94086 would like information on any Pascal compilers available for PRIME systems. (*80/01/23*)

Karl P. Lacher, 1132 W. Skillman Ave., Roseville, MN 55113: "I am an undergraduate at the Univ. of Minnesota in CSci. I was told about PASCAL NEWS by Andy Mickel who taught a SNOBOL short course I attended. PASCAL is definitely superior to FORTRAN." (*80/05/05*)

Carroll R. Lindholm, P.O. Box 3007, Santa Monica, CA 90403: "Please do not attempt to push state-of-the-art in print size reduction. My eyes are out for days after receiving an issue." (*80/01/21*)

Thomas J. Loeb, 2106 E. Park St., Arlington Heights, IL 60004: "We have formed a small user's group here in Arlngton Heights. The majority of us are firmly based in BASIC and are finding the transition to Pascal most iteresting.... We are unable to find any books that explain how to put the language to practical application. All the information we have been able to locate seems to be directed to the classroom or beginning programmers." (*80/04/06*)

Gary Loitz, 575 S. Rengstorff Ave. #157, Mountain View, CA 94040: "Using OMSI Pascal V1.2 as the primary implementation language for the Watkins-Johnson Magnetic Bubble Memory test system." (*80/02/06*)

Robert S. Lucas, 6941 N. Olin Ave., Portland, OR 97203: "Keep up the good work!!" (*80/05/05*)

James W. Lynch, Computer Services Marketing, Babcock & Wilcox, P.O. Box 1260, Lynchburg, VA 24505: "New to PUG; have Pascal available on NOS & NOS/BE; used by our service bureau customers & limited internal applications; use here is growing but not widespread; am looking forward to 7600 version." (*80/05/05*)

George A. Martinez, 654 1/2 S. Soto St., Los Angeles, CA 90023: "Keep up the good work. You guys are just great." (*80/01/05*)

David Paul McCarthy, 1532 Simpson #1, Madison, WI 53713: "Keep up the fine work." (*80/04/01*)

John J. McCandliss, 12164 Wensley Road, Florissant, MO 63033: "I am very happy to know that you are continuing the 'Pascal News' in the same fashion as before." (*80/01/20*)

Fred McClelland, 5319 Northridge Ave., San Diego, CA 92117: "Would it be possible for you to reprint the first eight issues of Pascal News?? I would be very interested in purchasing them. (*80/01/21*)

Paul McJones, Xerox Corp., 3333 Coyote Hill Road, Palo Alto, CA 94304: "I would like to see more on languages derived from Pascal, such as Modula and Mesa." (*80/04/03*)

Tony Meadow, P.O. Box 5421, Oxnard, CA 93031: "The PUG Newsletter is one (*of*) the most enjoyable & readable journals/books/... in the computer field - and it's not stuffy at all! Keep it up! Some of the features in it which I find of especial interest is the software exchange and information on current implementations of PASCAL." (*80/01/03*)

Bert Mendelson, McConnell Hall, Smith College, Northampton, MA 01063: "We have switched our introductory course to PASCAL, originally using OMSI PASCAL and will change to DEC's version on our VAX." (*80/03/31*)

Paul Minkin, 3141 Rhode Island Ave. S., St. Louis Park, MN 55426: "Leaving a Concurrent Pascal compiler project & finding myself in an assembly language world has made the benefits of Pascal very clear. I finally have the OMSI compiler & will send more as we use Pascal in the CAD/CAM world. My new company is National Computer Sys. CDM Division." (*80/02/14*)

C. W. Misner, Dept of Physics, Univ. of Maryland, College Park, MD 20742: "Teaching myself programming after 15 years away from it by writing a gradebook editor/analyser." (*80/01/04*)

David V. Moffat, Rt. 7 Box 52A, Chapel Hill, NC 27514: "At N.C.S.U., we run several Pascals: A.A.E.C., Stony Brook, on 370; sequential & concurrent, on PDP-11; soon will try Ga. Tech & U. of Hull on a PRIME, and somebody's (?) on the VAX. There is a movement here to use Pascal in intro courses when a friendly, informative, cheap compiler is found." (*80/01/04*)

Hugh W. Morgan, 7725 Berkshire Blvd., Powell, TN 37849: "I have recently purchased Pascal from North Star...since this is my first experience with PASCAL and since I am a computer novice with no experience with machine or assembly language this has been a real experience for me, or perhaps I should say ordeal... If you have any information, or can refer me to any published articles which may help me get the terminal options worked out I would be very grateful to you... Now that PASCAL is running I am very much like the dog which finally caught the school bus. The dog didn't know what to do with the bus and I don't know what to do with PASCAL. That's where I hope the PASCAL NEWS and User's Group may help." (*80/01/05*)

Morgan Morrison, Unicorn Systems Company, Suite 402, 3807 Wilshire Blvd., Los Angeles, CA 90010: "We are engaged in the implementation of a software product that is being written in PASCAL. We are interested in CDC Cyber PASCAL implementations." (*80/02/24*)

Timothy A. Nicholson, 97 Douglass Ave., Atherton, CA 94025: "Will be using SLAC Pascal on IBM & UCSD Pascal on Apple." (*80/05/05/*)

Bill Norton, M.H.S. Div., Harnischfeger Corp., 4400 W. National, Milwaukee, WI 53201: "Keeping the present PUG structure and mission is the best way to go. Best of luck to Rick Shaw and friends. Can't use Pascal much right now, but want to stay current." (*80/01/21*)

Thomas J. Oliver, Blue Hills, Dewey, AZ 86327 has a micro and plans to mainly work on alpha numeric, gray scale, pictorial maps and some LANDSAT satellite algorithms." (*80/03/20*)

Ross R. W. Parlette, Chemical Systems, United Technologies, P.O. Box 35B, Sunnyvale, CA 94086: "I went to a 1 day seminar to introduce Pascal; it was very helpful. We hope to have the Validation Suite ready on the VAX for DEC Pascal in Feb. '80. (*80/01/23*)

Jeff Pepper, 5512 Margaretta St. #3, Pittsburgh, PA 15206: "Glad you exist!" (*80/02/24*)

James G. Peterson, 1446 6th St., Manhattan Beach, CA 90266: "Keep up the good work! Some form of advertising might be worthwhile, so that more people would know about PUG. I am writing a large CAD system with PASCAL at TRW DSSG." (*80/01/21*)

Gregory N. Pippert, 1200 Columbia Ave., Riverside, CA 92507: "I am using Electro Science Ind. Pascal to drive an ESI Laser system which is used to trim thick-film potentiometers." (*80/02/14*)

Fred Pospeschil, 3108 Jackson St., Bellevue, NC 68005: "I am looking for Pascal implementations on Heath H8 computers" (* That's a PDP-8 architecture *) (*80/04/03*)

Hardy J. Pottinger, EE Dept., Univ. of Missouri, Rolla, MO 65401: "Keep up the good work! I am using Pascal as a microcomputer system development language." (* 80/01/23*)

Fred W. Powell, P.O. Box 2543, Staunton, VA 24401: "I am now using Pascal on a TI 990/10. Thanks for such a tremendous job with Pascal News." (*80/01/08*)

Charles A. Poynton, 113 Chaplin Cr, Toronto, Canada M5P 1A6: "I anxiously and eagerly await each issue; keep up the excellent work!" (*80/02/14*)

Robert M. Pritchett, Trans-National Leasing, Inc., Box 7245, Dallas, TX 75209 is looking for Pascal for the IBM Series/1 running the EDX operating system, or for source code for a Pascal compiler/interpreter on IBM standard 8-inch single-density diskettes, 128 bytes per sector, single or double sided.

Paul Rabin, Philadelphia Health Mgmt. Corp., 530 Walnut St., 14th Floor, Philadelphia, PA 19106: "I am interested in using Concurrent Pascal to implement a real-time dispatch system for the Phila. fire dept. I am looking for D.G. implementations or help converting another to D.G." (*80/04/03*)

Armando R. Rodriguez, c/o S.P. Wovda, Armanspeergstrasse 15, 8000 Muenchen 90, West Germany: "Coming soon: I'll have all PUG software tools in diskette (8 inch, single density, one-sided) to distribute and/or exchange for other tools." (*80/01/07*)

Bernie Rosman, 864 Watertown St., W. Newton, MA 02165: "We use Pascal heavily at Framingham State College and all in-house software at Paramin, Inc....is written in Pascal. Keep up the good work!" (*80/01/21*)

Ira L. Ruben, 2104 Lincoln Dr. East, Ambler, PA 19002: "Have used Pascal to code a Floyd-Evans production metacompiler, also currently designing and coding a communications system (Univac 'DCA') in Pascal. The language is the best I have ever used for implementation except for its lack of data alignment control and packing control, which is needed when processing bit-oriented protocols. PUG is good, but it would be nice if the news came out at more predictable intervals!" (*80/01/21*)

William John Schaller, 4309 28th Ave. S., Minneapolis MN 55406: "I work for Sperry Univac. We are developing a graphics system on a color terminal (Chromatics). We are using UCSD Pascal on a Z80 to accomplish this." (*80/05/05*)

G. A. Schram, Dr. Neher-Laboratories, P.O. box 421, 2260 AK Leidschendam, The Netherlands would like to know about the availablility of a DEC-10 or PDP-11 Pascal cross-compiler for the M6800 or Z-80. (*79/11/07*)

Herbert Schulz, 5820 Oakwood Dr., Lisle, IL 60532: "I've been very excited about Pascal ever since reading about it in BYTE. Have had UCSD Apple Pascal since it came out and just got UCSD Pascal for our H-11/A at the Community College where I teach. Will be teaching Pascal to the faculty next term. I'd appreciate any help for that task!" (*80/04/01*)

Ted Shapin, 5110 E. Elsinore Ave, Orange, CA 92669 sends word that Dr. Donald Knuth and Dr. Luis Trabb Pardo at Stanford University are working on a typesetting system, to be implemented in Pascal.

Richard Siemborski, Communicatons & Computer Sciences Dept., Exxon Corp., Box 153, Florham Park, NJ 07932: "I would like a copy of the listing of ALL known PASCAL implementations for micro's, mini's, and mainframes." (*80/02/03*)

Seymour Singer, Bldg. 606/M.S. K110, Hughes Aircraft Co, P.O. Box 3310, Fullerton, CA 92634: "We are offering a 12-week class on PASCAL programming to Hughes personnel using Grogono's text. We have installed both the SLAC and HITAC compilers on our twin Amdahl 470 V/8 computers. The response to this class has been overwhelming! Many students have bought the UCSD system on the Apple microcomputer." (*80/01/10*)

K R Smith, 1632 Hialeah St., Orlando, FL 32808: "Have just ordered HP/1000 (RTE IVB) Pascal. I'll let you-all know as I start using it." (*80/05/05*)

Jon L. Spear, 1007 S.E. 13th Ave., Minneapolis, MN 55414: "I am working with Prof. S. Bruell and G. M. Schneider on a text: "Advanced Programming and Problem Solving with Pascal" which may be available from Wiley by the fall." (*80/05/06*)

E. L. Stechmann, ARH272, Control Data Corp., 4201 N. Lexington Ave., St. Paul, MN 55112: "I enjoy PUG very much: Pascal News is a high point in a day....Question: How can we get the big mainframe manufacturers to accept & support Pascal to the same extent as FORTRAN & COBOL?" (*80/05/06*)

Andrew Stewart, 11 Woodstock Rd., Mt. Waverley, VIC 3149, Australia: "Pascal is a marvellous language because it is so simple and Elegant. I think Pascal News is an excellent means of communication (when it comes!)" (*80/04/14*)

Frank M. Stewart, Mathematics Department, Brown University, Providence, RI 02912: "I have only today learned of your invaluable organization." (*80/03/31*)

Jerry S. Sullivan, Philips Laboratories, 345 Scarborough Road, Briarcliff Manor, NY 10510: We have made extensive use of the UCSD Pascal System, written a MODULA compiler in Pascal, (* and *) written a number of micro operating systems in MODULA." (*80/03/31*)

Anthony J. Sutton, 1135 W. 4th St., Winston-Salem, NC 27101 is looking for a Pascal implementation under VM/370 CMS (conversational monitor). (*80/01/23*)

K. Stephen Tinius, 1016 Halsey Drive, Monterey, CA 93940: "I am a student at the Naval Postgraduate School here in Monterey.... PASCAL is taught in our...Introduction to programming course, which follows (usually) intros to COBOL and FORTRAN. We run UCSD PASCAL on Altos microprocessors....For my thesis, I'm (trying) to implement NPS-Pascal on Intel hardware to run under CP/M." (*80/01/23*)

Mike Trahan, University Computing Company, 1930 Hi Line Drive, Dallas, TX 75207: "UCC is using PASCAL Release 3.0.0 on a CDC Cyber 175 and CDC 6600 running the NOS/BE v.1.3 - PSR 498 operating system. We use PASCAL for applications programs, utility programs and general programming." (*80/01/05*)

Transmatic Company, Rt. 2, Box 86, Hamlin, TX 79520 has been moving some programs from other machines onto Texas Instruments Pascal with great difficulty because it does not meet the minimum conformance standards. However, it takes less than two seconds to do a job which takes over three and a half minutes on the same machine in BASIC. (*80/04/22*)

Frederick John Tydeman, 3901 Northfield Road, Austin, TX 78759: "Finished my master's in computer science: 'Abstract Machines, Portability, and a Pascal Compiler'. Defined M-code (mobile code) as an intermediate language and implemented a portable Pascal compiler using it." (*80/03/31*)

Stan Veit, Veit's Diversified Operating Systems Ltd., 19 W. 34th St., Room 1113, New York, NY 10001: "We are eastern reps for A.C.I. (* Pascal microengine *) and a Pascal software house." (*80/02/24*)

Ray Vukcevich, 7840 N. 7th St. #1, Phoenix, AZ 85020 would like to know where to get Pascal on a single density PerSci 8" disc for an Imsai 8080 with 56K. (*79/12/28*)

Howard White, Jr., 799 Clayton St., San Francisco, CA 94117 would like information on Pascal 8000 as developed by the Australian Atomic Energy Commission; he is especially interested in references, bibliographies, and user feedback. (*80/03/18*)

Jerome P. Wood, 6105 Harris, Raytown, MO 64133 is interested in Pascal compilers for an IBM S/370 at work. (*80/02/03*)

Stephen Woodbridge, 642 Stearns Ave., Palm Bay, FL 32905: "Please keep up the great work. #13 is my 1st issue and I can't get enough of it." (*79/12/28*)

R. P. Wolff, Ajax Corp., W154 N8105 Elm La., Menomonee Falls, WI, 53051: "Are any compilers available for a 'Microdata Reality or Royale' system?" (*80/01/23*)

George O. Wright, 700 7th St. SW 635, Washington, DC 20024: "Please be friendly to UCSD PASCAL and micro users!" (*80/02/23*)

Earl M. Yavner, 195 Varick Rd., Newton, MA 02168: "Have just heard that Hewlett Packard will have PASCAL for HP1000 systems in a few months. Will send info as I get it." (*80/04/01*)

Dr. Richard Yensen, 2403 Talbot Road, Baltimore, MD 21216: "LOVE screen interactive features of UCSD Pascal. We need an interchange format for screen control on different CRT terminals." (*80/05/06*)

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JOBS:

(* Note-these listings are intended primarily to show that there are indeed openings for Pascal programmers "out there". By the time you see these listings, the jobs may well be filled. *)

Allen-Bradley, 747 Alpha Drive, Highland Heights, OH 44143, wants software engineers to "apply your software experience - assembly languages, PASCAl, FORTRAN" on a VAX 11/780, DEC 11/34 or TEKTRONIX Development system. (*80/04/24*)

Control Data Corporation, 4201 N. Lexington Ave., Arden Hills, MN 55112 is looking for diagnostic engineers to "utilize both...hardware and softare aptitudes...in maintenance software systems development and PASCAL applications programming."

Medtronic, Inc. 3055 Old Highway Eight, P.O. Box 1453, Minneapolis, MN 55440 "has a position that recognizes your BSEE, and 6-8 years experience with PASCAL-based computer simulation..." (*80/03/24*)

MTS Systems Corp. P.O. Box 24012, Minneapolis, MN 55424 is looking for a software development engineer for products "based upon latest microprocesor technology. PASCAL and assembly language will be used for implementation." (*80/03/10*)

The New York State Legislature, 250 Broadway - 25th Floor, New York NY 10007 wants a demographer, cartographer, and junior programmers. All applicants "should have practical computer programming experience in FORTRAN, COBOL, or PASCAL." (*80/03/10*)

Northern Telecom, P.O. Box 1222, Minneapolis, MN 55440 is looking for a senior programmer/analyst with "high-level programming language (PASCAL, COBOL, BASIC) and compiler writing." (*80/03/24*)

Texas Instruments, P.O. Box 401628, Dallas, TX 75240, has openings in Dallas and Lewisville, Texas, to work "with real-time software applications for mini/micro computer based systemss and on distributed computer architectures and uni-processor systems." One of the languages: Pascal.

(* Andy Mickel passed on to me the following Want Ad, which appeared in the March 1980 issue of the Pug Press, published by Maryanne Johnson of Excelsior, MN 55331. It is offered here, verbatim, without further comment... *)

WANTED - Small PUG stud to breed with the Classiest Bitch in Town. Stud must be experienced yet gentle, loving, and discreet. Contact Ron or Marlys Hampe (612)-890-4141

MANUFACTURERS' ADVERTISEMENTS:

(* A lot of these advertisements appear in several publications; this list is gleaned from a "spot check" of several months' worth of magazines and trade journals. Where a product description is much more detailed than the information given here, a reference is provided. *)

Associated Computer Industries, Inc. 17751 Sky Park East, Suite G, Irvine, CA 92714, announced a Pascal Video terminal for use with UCSD Pascal. It accomodates several international languages character displays by internal switch changes, with no optional ROM required. They also sell the ACI-90 Pascal Professional Performance Computer, based on the Western Digital Microengine. Includes the UCSD Pascal operating system, and business software: General Ledger, Accounts Payable, Accounts Receivable, Payroll, and Order Entry Inventory.

Hewlett-Packard Data Systems Divison, Dept. 370, 1100 Wolfe Road, Cupertino, CA 95014 offers Pascal for the HP/1000 computer; it has added double-word integer, double-precision data types, random access I/O, and external FORTRAN and assembly language capability.

Intel Corporation of Santa Clara now has Pascal for its Intellec development systems, as reported in the Intel Preview of February 1980. It "encompasses the full standard...as defined in Pascal User Manual and Report by Jensen and Wirth", and "...offers several more extensions to the UCSD Standard." The blurb also notes, "The UCSD Pascal implementation has become the industry standard and was the first such implementation of this relatively new programming language." (* The person who sent me this noted, in the margin, "!!!". I agree. *)

Meta Tech, 8672-1 Via Mallorca, La Jolla, CA 92037 advertises Pascal/MT, a compiler running under CPM in 32K bytes or more. Compiles a subset of Pascal into ROMable 8080/Z80 code. Object code costs $100, source code costs you OEMs $5000.

North Star, 1440 Fourth St., Berkeley, CA 94710, advertises Pascal for its Horizon system.

Oregon Software, 2340 S.W. Canyon Road, Portland, Oregon 92701 announced OMSI Pascal V1.2 with symbolic debugger and profiler, for any RSTS/E, RT-11, RSX-11, or IAS operating system. (* Computerworld 80/01/28*)

Rational Data Systems, 245 W. 55th St., New York, NY 10019 has Pascal for Data General computers, and also puts out a small Pascal Newsletter. (* And, in my opinion, it looks very nice! *)

Renaissance Systems, Inc., Suite M, 11760 Sorrento Valley Rd., San Diego, CA 92121 offers Proff and Forml, word processing support programs for formatting and printing text files and aiding in document generation. Written in UCSD Pascal, the combination costs $500. Documentation costs $25. (* Computerworld 80/01/14 p. 50 *)

SofTech Microsystems, 9494 Black Mountain Road, San Diego, CA 92126, offers UCSD Pascal "with full documentation and support."

Valley Software Inc., 390-6400 Roberts Street, Burnaby, B.C. Canada V5G 4G2 is a systems/design, programming and consulting service offering Pascal compilers for DEC and Data General.

NEWSLETTERS & ARTICLES:

Brown University Computer Center has arranged to lease a new PASCAL compiler developed at the University of Waterloo; it is the PASCAL described in the British Standards Institute DPS/14/3 Working Draft/3...it offers extended I/O capabilities to allow convenient acces to CMS files. (* March 1980 *)

The Institue for Information Systems, Mail Code C-021, University of California at San Diego, La Jolla, CA 92093 is publishing newsletters describing the UCSD Pascal System.

Mr. Jim McCord sends a "UCSD Pascal Hobby Newsletter #1." (* Sorry, I have no address on this; could someone out there please provide it? *)

The University of Michigan Computing Center presented a short course on Pascal this April. In the blurb, the newsletter states that..."Pascal offers significant advantages over other languages for general purpose programming." (*80/03/19*)

(* Ah-ha! Here's the article that answers just about all of the "can I get a version of Pascal for my [fill- in-the-blank] microcomputer?" questions. *)

Mini-Micro Systems April 1980 Issue has a lengthy article (pp. 89-110) entitled "High-level languages for microcomputers", by Mokurai Cherlin. Along with the article is a table of microcomputer high-level language suppliers; there are over 40 suppliers of Pascal for fifteen different chips.

The Northwestern University newsletter announced the arrival of the Pascal Release 3 compiler for the Cyber, with compiler options for selecting run-time tests and post-mortem dumps; and defining file buffer and central memory sizes. (*April 1980*)

The University of Southern California is forming a Users Group for PASCAL and ALGOL users. (*Feburary 1980*)

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Commodore displayed a version of Pascal for their PET personal computer at NCC. The compiler was developed in Great Britain.

While at NCC, I heard a rumor that someone is developing a version of Pascal for the Atari 800 personal computer.

I have seen an advert [in Japanese, unfortunately, so I can't give details] for UCSD Pascal for the NEC PC-8000 personal computer, which has colour graphics. The PC-8000 has been on the market in Japan for some months now, and it appears they may be marketing in the U.S. by year's end.

There was a session on Pascal at NCC, according to one of the attendees, it was fairly interesting. He said Ken Bowles spent some of his speaking time trying to defend his position re UCSD Pascal and Softech. Those who are interested in this subject may wish to take a look at past issues of INFOWORLD. Adam Osborne recently wrote a column which seems to address the issue quite objectively and unemotionally. (* NO, I am NOT going to say what I think of the whole thing. Mom always told me not to discuss religion and politics. *)

The Canadian Information Processing Society held their "Session '80" in Victoria, British Columbia in early May. A good time was had by all. While working the booth for Apple, I noticed that most of the people from universities had an interest in Pascal or were using it in their classes. The business community was aware of Pascal, more so than they may have been in the past, but didn't seem to be as familiar with its capabilities and wide usage. (* Unabashed plug: Victoria is a very beautiful city, and all the people I met were very friendly. It was great. *)

Rick Shaw, Editor
Pascal News
Digital Equipment Corporation
Atlanta, Georgia

6 August, 1980

Mr. Shaw:

Enclosed is a copy of "A Pascal Bibliography (June 1980)". Although it excludes references to articles on Pascal appearing in magazines such as BYTE and Datamation, it may be of some interest to your readers. (* See Page 12 -ed. *)

If anyone wishes to inform me of errors or omitted articles, I would be grateful to hear from him.

Respectfully,

David V. Moffat
Department of Computer Science
North Carolina State University
Raleigh, North Carolina 27650

BOOKS ABOUT PASCAL

(* This is a complete listing of all known books about Pascal *)

Alagic, S. and M. S. Arbib, The Design of Well-Structured and Correct Programs, Springer-Verlag, 1978, 292 pages, $12.8Ø.

Bowles, K. L., Microcomputer Problem Solving Using Pascal, Springer-Verlag, 1977, 563 pages, $9.8Ø.

Bowles, K. L., Beginner's Guide for the UCSD Pascal System, Byte Books, 198Ø, $11.95.

Brinch-Hansen, P., The Architecture of Concurrent Programs, Prentice-Hall, 1977, $22.ØØ.

Coleman, D., A Structured Programming Approach to Data, MacMillan Press, London, 1978, 222 pages.

Conway, R. W., Gries, D. and E. C. Zimmerman, A Primer on Pascal, Winthrop Publishers, 1976, 433 pages.

Conway, R., Archer, J. and R. Conway, Programming for Poets: A Gentle Introduction Using Pascal, Winthrop Publishers, 1979, 352 pages, $11.95.

Findlay, B. and D. Watt, Pascal: An Introduction to Methodical Programming, Computer Science Press (UK Edition by Pitman International), 1978.

Grogono, P., Programming in Pascal, Addison-Wesley, 1978, 359 pages, $11.5Ø.

Hartmann, A. C., A Concurrent Pascal Compiler for Minicomputers, Springer-Verlag Lecture Notes in Computer Science, No. 5Ø, 1977, $8.4Ø.

Jensen, K. and N. Wirth, Pascal User Manual and Report, Springer-Verlag Lecture Notes in Computer Science, No. 18, 2nd Edition, 1975, 167 pages, $6.8Ø.

Kieburtz, R. B., Structured Programming and Problem-Solving with Pascal, Prentice-Hall, 1978, 365 pages, $12.95.

Ledgard, H. F. and J. F. Hueras, Pascal With Style: Programming Proverbs, Heyden, 198Ø, 224 pages, $6.95.

Liffick, B. W. (Ed), The BYTE Book of Pascal, Byte Books, 198Ø, 342 pages, $25.ØØ.

Rohl, J. S. and H. J. Barrett, Programming via Pascal, Cambridge University Press, in press.

Schneider, G. M., Weingart, S. W. and D. M. Perlman, An Introduction to Programming and Problem Solving with Pascal, Wiley and Sons, 1978, 394 pages.

Webster, C. A. G., Introduction to Pascal, Heyden, 1976, 152 pages, $11.ØØ.

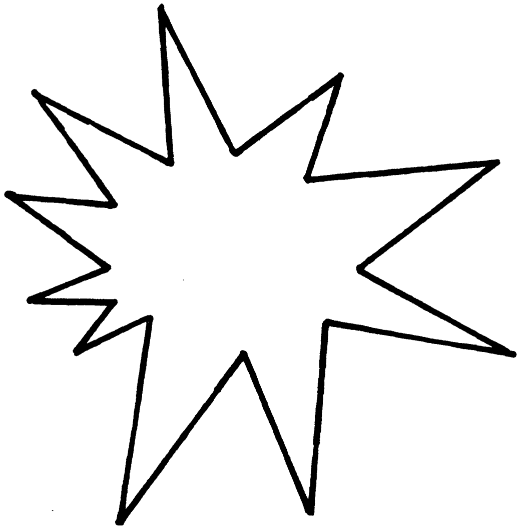
Wegner, P., Programming with ADA: An Introduction by Means of Graduated Examples, Prentice-Hall, 198Ø, 211 pages.

Welsh, J. and J. Elder, Introduction to Pascal, Prentice-Hall, in press.

Wilson, I. R. and A. M. Addyman, A Practical Introduction to Pascal, Springer-Verlag, 1978, 144 pages, $7.9Ø.

Wirth, N., Systematic Programming: An Introduction, Prentice-Hall, 1973, 169 pages, $19.5Ø.

Wirth, N., Algorithms + Data Structures = Programs, Prentice-Hall, 1976, 366 pages, $2Ø.95.



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(* These articles have appeared since the preparation of #17. *)

Addyman, A. M., "A Draft Proposal for Pascal", SIGPLAN Notices, Vol. 15, No. 4, April 1980.

Addyman, A. M., "Pascal Standardization", SIGPLAN Notices, Vol. 15, No. 4, April 1980.

Baker, Henry G., "A Source of Redundant Identifiers in Pascal Programs", SIGPLAN Notices, Vol. 15, No. 2, Feb. 1980.

Bond, Reford, "Another Note on Pascal Indention", SIGPLAN Notices, Vol. 14, No. 12, Dec. 1979.

Bron, C. and E. J. Dijkstra, "A Discipline for the Programming of Interactive I/O in Pascal", SIGPLAN Notices, Vol. 14, No. 12, Dec. 1979.

Byrnes, John L., "NPS-Pascal: A Pascal Implementation for Microprocessor-Based Computer Systems", Naval Postgraduate School, June 1979, 283 pages, NTIS Report AD-A071 972/4WC.

Cichelli, Richard J., "Pascal-I - Interactive, Conversational Pascal-S", SIGPLAN Notices, Vol. 15, No. 1, Jan. 1980.

Cichelli, Richard J., "Fixing Pascal's I/O", SIGPLAN Notices, Vol. 15, No. 5, May 1980.

Cornelius, B. J., Robson, D. J. and M. I. Thomas, "Modification of the Pascal-P Compiler for a Single-accumulator One-address Minicomputer", Software - Practice and Experience, Vol. 10, 241-246, 1980.

Kaye, Douglas R., "Interactive Pascal Input", SIGPLAN Notices, Vol. 15, No. 1, Jan. 1980.

Ljungkvist, Sten, "Pascal and Existing Fortran Files", SIGPLAN Notices, Vol. 15, No. 5, May 1980.

Luckham, David C. and Norihisa Suzuki, "Verification of Array, Record and Pointer Operations in Pascal", ACM Transactions on Programming Languages and Systems, Vol. 1, No. 2, Oct. 1979.

Luckham, D. C., German, S. M., Henke, F. W. V., Karp, R. A. and P. W. Milne, "Stanford Pascal Verifier User Manual", Stanford Univ. Dept. of Computer Science, Mar. 1979, 121 pages, NTIS Report AD-A071 900/5WC.

Machura, Marek, "Implementation of a Special-Purpose Language Using Pascal Implementation Methodology", Software-Practice and Experience, Vol. 9, 931-945, 1979.

Mateti, P., "Pascal Versus C: A Subjective Comparison", Proceedings of the Symposium on Language Design and Programming Methodology, Sydney, Australia, Sept. 1979.

Mattsson, Sven Erik, "Implementation of Concurrent Pascal on LSI-11", Software - Practice and Experience, Vol. 10, 205-217, 1980.

Runciman, Colin, "Scarcely Variabled Programming & Pascal", SIGPLAN Notices, Vol. 14, No. 11, Nov. 1979.

Sale, Arthur, "Miniscules and Majuscules", Software - Practice and Experience, Vol. 9, 915-919, 1979.

Shimasaki, M., Fukaya, S., Ikeda, K. and T. Kiyono, "An Analysis of Pascal Programs in Compiler Writing", Software - Practice and Experience, Vol. 10, 149-157, 1980.

Shrivastava, S. K., "Concurrent Pascal with Backward Error Recovery: Language Features and Examples", Software - Practice and Experience, Vol. 9, 1001-1020, 1979.

Shrivastava, S. K., "Concurrent Pascal with Backward Error Recovery: Implementation", Software - Practice and Experience", Vol. 9, 1021-1033, 1979.

Simpson, D., "Structured Programming and the Teaching of Computing: Experience With Pascal", Sheffield City Polytechnic Dept. of Computer Studies, Sheffield, England, 1979.

Sites, Richard L. and Daniel R. Perkins, "Universal P-Code Definition, Version (0.3)", Univ. of California at San Diego Dept. of Electrical Engineering, July 1979, 45 pages, UCSD/CS-79/037, NTIS PB-298 577/8WC.

Smith, G. and R. Anderson, "LSI-11 Writable Control Store Enhancements to UCSD Pascal", Lawrence Livermore Labs, Oct 1978, 112 pages, UCRL-81808(Sup), NTIS UCID-18046.

Wegner, Peter, "Programming with ADA: An Introduction by Means of Graduated Examples", SIGPLAN Notices, Vol. 14, No. 12, Dec. 1979.

Welsh, J. and D. W. Bustard, "Pascal-Plus - Another Language for Modular Multiprogramming", Software - Practice and Experience, Vol. 9, 947-957, 1979.

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David V. Moffat
North Carolina State University
Raleigh, North Carolina

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REVIEW: PASCAL With Style: Programming Proverbs

"PASCAL With Style: Programming Proverbs" (Hayden Book Company, Rochelle Park, New Jersey, USA, 1979) is an addition to "[BASIC, COBOL, FORTRAN] With Style: Programming Proverbs" by Henry Ledgard (with various others). "PASCAL" is co-authored by Paul Nagin, and John Heuras. All three authors are at the University of Massachusetts. This volume, like its predecessors, is "intended for ... programmers who want to write carefully constructed, readable programs". I feel compelled to point out that "PASCAL" is used throughout this book in place of the traditional, and correct, "Pascal", and that this error is symptomatic of my main criticism of "PASCAL With Style" (PWS for short).

What Ledgard, et al, have done is to slightly rework the previous books (I believe "BASIC..." was first). The Proverbs are pithy, sometimes witty, "rules" for programmers. The present book shares the Proverbs with the others in the series. This is all to the good. But Pascal has been treated here as though is were like [BASIC, FORTRAN, COBOL]. And this is where Ledgard, et al, have not done so well. They have failed to address the characteristics of Pascal which make it different from other languages. Thus, they treat Pascal's name as though it were an acronym, because "FORTRAN" and "BASIC" and "COBOL" are acronyms. This approach is also reflected in some suprising assertions. On page 35 they state that one should make sure all constant data items are declarated as such. Fine. In the next sentence, though, they say that no executable statement should "modify" (redefine?) the value of a constant. In Pascal, of course, constants simply can not be "modified". On page 82, and elsewhere, identifiers such as "GAME_MOVE" are used. Perhaps this would be legal in PL/I, but not in Pascal.

Experienced Pascal programmers reading PWS would spot most of these quirks, make a mental note, and move along. The novice, though, could conceivably be mislead, and that would be most annoying.

PWS is a letdown, not so much because of the (trivial) errors of commission, but because of the gaps left unfilled. Recursion, for example, is dismissed with 10 short paragraphs. There is a reference to "a good deal of the literature" being devoted to recursion (p.138), but no specific references are given. But at least recursion is mentioned: pointer types (and their proper use) are totally ignored. Structured types treated include only arrays. Perhaps I misinterpret the authors' intentions, but it does seem that in Pascal, especially, data representation is an important part of making programs comprehensible to the human mind. And making programs comprehensible (and correct) is what programming style is all about. Sets, subranges, and record types are simply not treated.

There are a few niggling syntax errors. On page 118, for example, a "(" is ommitted in a procedure declaration. This is curious, and I mention it only because parts of the book appear to have been printed by a Decwriter, implying the text was machine-readable. Why not all of it? That way, they could have done some editing and had a compiler look at the examples - a good way to eliminate errors. (In fact, Kernighan and Plauger used this technique in "Software Tools" (McGraw-Hill), wherein RATFOR was presented.)

Despite the above, PWS is not a useless book. I found the section treating top-down techniques to be useful. PWS describes other approaches to problem definition/solution and explains why they fail so often. The authors lay out in detail the process of successive refinement. This is clear and to the point. The bibliography contains the standard references to Wirth, Dijkstra, etc., as well as several less well known sources. The Programming Proverbs are worth reading and knowing. They are presented with explanations of why they are important, and examples are given. Ledgard's pretty-printing program is presented in an appendix. This is written in fine style, as it should be. Sadly, no information is given on the possibility of acquiring a machine-readable version of the program. A list of style rules is developed by the authors. Many people writing Pascal could benefit from reading and following them. Others might make use of them as a starting point in developing their own style rules..

Finally, there are a lot of people who do not even think about style, or who think it is not important, or worst of all, who think they employ it but don't. PWS is concise, easy-to-read, and treats style in regard to algorithmic issues with reasonable success. For the programmer who has learned the syntax of Pascal, but who has not learned to express algorithms clearly, or how to approach problems in an organized, methodical fashion PWS could be a revelation. So even if you use good style (are you sure you do? how do you know?), you might want to spend $6.95 for PWS to lend to your colleagues - after all, you might have to read their code someday.

Christopher Amley
80/02/09

University of Minnesota
Agricultural Extension Service
415 Coffey Hall
St.Paul, Minnesota 55108 USA

Backissues of Pascal News(letter) from Time Zero - Andy Mickel 80/07/11.

Pascal Newsletter was started by George Richmond at the University of Colorado Computing Center in early 1974 primarily to spread information about the distribution of the CDC Pascal compiler and the Pascal-P compiler and to answer questions about other issues. He edited issues 1 through 4. In 1976 Pascal User's Group assumed control of Pascal Newsletter. I changed the name to Pascal News with issue 9. Below are some facts about issues 1 through 16.

Date	Issue	pages	(numbered)	Estimated printed copies
Jan 1974	Pascal Newsletter #1	8	(8)	200+SIGPLAN Notices 1974 Mar
May 1974	Pascal Newsletter #2	18	(18)	250+SIGPLAN Notices 1974 Nov
Feb 1975	Pascal Newsletter #3	19	(19)	400+SIGPLAN Notices 1976 Feb
Aug 1976	Pascal Newsletter #4	103	(103)	500+230 sent by PUG
Sep 1976	Pascal Newsletter #5	124	(65)	1150+350 UK
Nov 1976	Pascal Newsletter #6	180	(91)	1150+350 UK
Feb 1977	Pascal Newsletter #7	90	(45)	1150+350 UK
May 1977	Pascal Newsletter #8	128	(65)	1150+450 UK
Sep 1977	Pascal News #9/10(combined)	220	(113)	3500+600 UK+150 AUS
Feb 1978	Pascal News #11	202	(105)	3500+600 UK+150 AUS
Jun 1978	Pascal News #12	135	(69)	3500+600 UK+150 AUS
Dec 1978	Pascal News #13	239	(123)	4000+750 UK+250 AUS
Jan 1979	Pascal News #14	61	(61)	4100+750 UK+250 AUS
Sep 1979	Pascal News #15	247	(125)	4000+750 UK+250 AUS
Oct 1979	Pascal News #16	305	(155)	4000+750 UK+250 AUS

At PUG(USA) there are approximately 700 copies of 9-12 and 1100 copies of 13-16 left.

#9/10, page 11 describes the contents of Pascal Newsletters 1-8.
#11, pages 16-19 completely describe Pascal Newsletters 5-8.
#13, pages 16-18 completely describe Pascal News 9-12.

If you want indexed information about Pascal compilers, the story behind the Pascal Standards activity, the complete set of listings of software tools, and a complete roster of the PUG membership 1976-1979, there is no substitute for obtaining all the available backissues: 9-16.

Review of Pascal News 13, 14, 15, and 16. - Andy Mickel 80/07/11.

I would like to urge all new PUG members to consider obtaining backissues 13-16 so that you will be better oriented to events in our recent past.

To describe the highlights: #13 and #15 are the meaty issues. #13 contains the most recent, complete summary of all Pascal compilers to present. The articles in #13 are mostly centered on a lively discussion of control structures. #15 describes a lot of standards activity and the resolution of the future of Pascal News and PUG.

#14 is completely devoted to Working Draft 3 of the Pascal Standard, and #16 is completely devoted to a Validation Suite of more than 300 Pascal programs.

Pascal News #13, December, 1978, Pascal User's Group, University of Minnesota Computer Center, 239 pages (123 numbered pages), edited by Andy Mickel.

Editor's Contribution: Thanks to those people at the University of Minnesota who have given Pascal News the shadow of their smile, FORTRAN - The End at Last? Recent events: Employment opportunity, Concurrent Pascal, NASA and the Galileo Project, Conventionalized Extensions, Standards, Pascal Machines, Pascal Usage, Explosion in Industry Literature. Pascal User's Group / Pascal News status: why we are behind.

Here and There: News from Pascalers; a very large Pascal in the News; another Pascal T-shirt; Pascal in Teaching; Books and Articles; Conference reports: French AFCET Pascal Group, Australian Computer Science Conference, SIGPLAN ACM meeting, UCSD Pascal Workshop. A Review of Pascal News 9/10, 11, and 12. Roster Increment 78/04/22 - 10/31.

Applications: A review of Software Tools by Rich Cichelli; Algorithm A-1 comments, A-3 Determine Real Number Environment. Software Tool S-3 Prettyprint; S-4 Format.

Articles:

"Moving a Large Pascal Program from an LSI-11 to a Cray-1"
- Richard L. Sites
[A 2400-line Pascal program was moved between 2 machines whose CPU speed ratio is 150 to 1. The task proved easy and 6 portability problems are outlined. Lack of adherence to standards and incompatibilities in the run-time environment were the major areas of difficulty.]

"On the Article 'What to do After a While'"
-Roy A. Wilsker
[An examination of a table search algorithm is made with respect to considerations of "psychological set," "proving programs correct," "the spirit of Pascal," and "efficiency." Conditional evaluation of Boolean expressions as advocated in the original paper is not necessarily the solution.]

"A Resolution of the Boolean Expression-Evaluation Question or If Not Partial Evaluation Then Conditional Expressions"
- Morris W. Roberts and Robert N. Macdonald
[The language features of case expression, value block and the conditional expression are recommended as additions to Pascal taken from the precedents of ALGOL-60 and ALGOL-W. An analysis of several control structure constructs is given.]

"What to do After a While .. Longer"
- T.M.N. Irish
[A thorough reply to Mullins and Barron's article "What to do After a While" arguing against conditional Boolean expression evaluation. He says we should not 1) write programs that rely on ill-defined factors, side-effects of functions, or undefined values, 2) depend on implementors to let us get away with them, 3) tell implementors to let us get away with them, or 4) complain if implementors use any means they can devise to prevent us getting away with them.]

"Know the State You Are In"
- Laurence V. Atkinson
[A number of recent articles have highlighted problems with multiple exit loops in Pascal. Many of these problems disappear when a loop is controlled by a user-defined scalar. The state transition technique is applicable to a number of programming situations and to multi-exit loops in particular.]

Open Forum:

78/05/25 Sam Calvin to Andy Mickel: [Department of Defense Dependents schools use of Pascal in Math programs to teach K-12 students with personal instruction]
78/06/08 Dave Rasmussen to Andy Mickel: [Building Automation Systems process control language using Pascal, at Johnson Controls in Milwaukee]
78/04/24 C. Edward Reid to Andy Mickel: [corrections to letter of 78/03/16 in PN #12 p47]
78/12/01 Andy Mickel to PUG members: [The future of PUG and Pascal News; turning the editorship over to someone else. A proposed constitution]
78/07/17 Charles L. Hethcoat III to Andy Mickel: [The reference to "Implications of Structured Programming for Machine Architecture" by Andrew Tanenbaum in CACM describing EM-1 a compact instruction machine.]
78/07/28 C. Edward Reid to Andy Mickel: [Pointing attention to Dijkstra's article "DOD-1: The Summing Up"in SIGPLAN Notices and highlighting shortcomings]
78/07/29 Ralph D. Jeffords to Andy Mickel: [Annoucing the construction of 2 software tools in Pascal: LEXGEN and LALR1 for Syntax Parsing and Generating.]

78/08/23 Jim Merritt to Andy Mickel: [The impact and future of Pascal implementations on personal computer systems. Very optimistic.]
78/08/29 Chuck Beauregard to Andy Mickel: [Pascal jobs on the West Coast]
78/09/08 Eiiti Wada to Arthur Sale: [Experience with teaching Pascal at the University of Tokyo]
78/09/23 Rod Montgomery to Andy Mickel: [News in New Jersey about recent microcomputer Pascal events and the blossoming interest in UCSD Pascal]
78/07/10 Kenneth Wadland to Andy Mickel: [News about teaching Pascal at Fitchburg State College and support for Charles Fischer's method of standardization]
78/10/18 William C. Moore to Andy Mickel: [Need for a Pascal book with complete compiler specifics.]
78/10/10 D. J. Maine to Andy Mickel: [Pascal developments at Computer Automation--compilers and jobs]
78/09/25 H.H.Nagel to Andy Mickel: [General reactions to PUG's work; the DECSystem 10 implementation and incorporation of otherwise]
78/? Karl Fryxell to Andy Mickel: [Reaction to Judy Bishop's discussion of subranges and conditional loops]
78/08/16 Richard Hendrickson to Andy Mickel: [Problems with performance of CRAY Pascal compared to CRAY Fortran and problems with Pascal in general.]
78/09/04 Laurence Atkinson to Andy Mickel: [Comments on programming logic--use of Booleans instead of two-state scalars; negative logic]
78/09/27 Judy Bishop to T.M.N.Irish: [Clarification of points of agreement and disagreement about "What to do after a While."]

Pascal Standards:
Report by Andy Mickel on: corrections to EBNF by Niklaus Wirth; Distribution plans for the Validation Suite; Working Draft/3 will appear as Pascal News #14; News from the Internation Working Group on Pascal Extensions.
78/01/30 Niklaus Wirth to Andy Mickel: [Suggesting the formation of a small group of implementors to implement agreed-upon extensions]
78/07 Arthur Sale: Consensus Position on Case defaults--adding an otherwise clause.
78/06/12 Brian Wichmann to Andy Mickel: [Announcement of a Pascal Test Suite which is under development.]
78/09/15 Tony Addyman: Progress Report on the Standard Number 1. Plans for producing a draft for public comment by the BSI and submission to ISO.
78/09/12 Rick Shaw to Andy Mickel: [Will act as USA Standards liason to Tony Addyman; will draw up program interchange guidelines and gather test programs.]
78/09/27 Andy Mickel to William Hanrahan: [Urge that Pascal standardization be left to the BSI and not undertaken separately by ANSI.]
78/10/23 News Release by CBEMA on behalf of ANSI of the formation of ANSI committee X3J9 for Pascal standardization.
78/11/10 News Release by CBEMA on behalf of ANSI regarding first X3J9 meeting.

Implementation Notes:
General Information, Implementors Group Report, Checklist, Portable Pascals: Pascal-P, Pascal P4--Bug Reports, Pascal Trunk, Pascal J; Pascal Variants: Pascal-S, Concurrent Pascal, Modula; Feature Implementation Notes: INPUT and OUTPUT, Improved Checking of Comments, Lazy I/O; Machine-Dependent Implementations: Altos ACS-8000, Amdahl 470, BESM-6, BTI 8000, Burroughs 5700, 6700, 7700, CDC 6000, Cyber 70,170, 7600, Cyber 76, Cyber 203, Data General Nova, Eclipse, DEC PDP-8, PDP-11, VAX 11/780, DECsystem 10,20, Heathkit H-11, Hewlett Packard 21MX, 2100, Honeywell H316, IBM 360/370, Series 1, ICL 1900, 2900, Intel 8080, Interdata 7/32, 8/32, Marinchip M9900, MOSTEK 6502, Motorola 68000, North Star Horizon, Northwest Micro 85/P, Prime P-300, Processor Technology SOL, Radio Shack TRS-80, SEL 8600, Siemens 4004,7000, Telefunken TR-440, TI-ASC, 980,990,9900, Univac 90/70, 1100, Western Digital Microengine, Zilog Z-80,Z-8000; Index.

Pascal News # 14, January, 1979, Pascal User's Group, University of Minnesota Computer Center, 61 pages (61 numbered pages), edited by Andy Mickel.

Editor's Contribution: A special issue devoted to the Draft Pascal Standard. Notes that Pascal the language and its development have been unique. The appropriateness of letting Europeans standardize a language with European origins.

The BSI / ISO Working Draft of Standard Pascal by the BSI DPS/13/4 Working Group. Letter, Covering Note and Commentary by Tony Addyman; The Draft (6 sections + index); Related Documents: A history, members of DPS/13/4 and the ISO proposal.

Pascal News #15, September, 1979, Pascal User's Group, University of Minnesota Computer Center, 247 pages (125 numbered pages), edited by Andy Mickel.

Editor's Contribution: Why Pascal News #15 is so late and thanks for not giving up hope. The future of PUG and Pascal News. Voting on the proposed constitution. Rick Shaw as new editor. Jottings on the standard, Validation Suite, Distribution problems, and Pascal on Micros.

Here and There: Tidbits (news from Pascalers), a very large Pascal in the News, Ada, Books and Articles including a Textbook survey, Conferences and Seminars (4 Industry Seminars to be given on Pascal), Announcements for ACM 79 and IFIP 80 2 reports on the DECUS Pascal SIG ; Pascal session at ACM 78. PUG Finances 77-78; Roster Increment to 79/05/14.

Applications: News: Business Packages available, Data Base Management Systems, Interpreters Inter-language translators, Bits and Pieces. Software Tools: changes to S-1 Compare, S-2 Augment and Analyze on the Dec 10, S-3 Prettyprint clarifications, S-4 Format confessions, S-5 ID2ID documentation + program, S-6 Prose documentation + program. Programs: P-1 PRINTME. Algorithms: A-3 Perfect Hashing Function.

Articles:
"A Contribution to Minimal Subranges"
- Laurence V. Atkinson
[Enumerated and subrange types are two of the most important features of Pascal. Their contribution to transparency, security and efficiency is often not fully appreciated. Their under-utilization is one of the (many!) features I repeatedly criticize when reviewing Pascal books. Minimal subranging is desirable in Pascal. One benefit of a state transition approach to dynamic processes, is that minimal subranging can be achieved.]

"A Note on Scope, One-Pass Compilers, and Pascal"
- Arthur Sale
[The scope rules set out in section 2 and now incorporated into the draft Pascal Standard are sufficient to permit even one-pass compilers to reject incorrect programs. The suggested algorithm adds an overhead at every defining occurrence, but since uses exceed definitions in general it may not be too expensive in time to implement. In any case, what price can be put on correctness?]

"Pascal-I - Interactive, Conversational Pascal-S"
- Richard Cichelli
[Pascal-I is a version of the Wirth Pascal-S system designed to interact with the terminal user. The system contains a compiler, interpreter, text editor, formatter, and a run-time debugging system. A description of commands and a terminal sesstion are given.]

"Tracing the Heap"
- Steve Schach
[The package HEAPTRACE outlined in this paper aids the user to debug his programs by providing information as to the contents of the records on the heap. Each field is named, and its value is given in what might be termed "high-level format".]

"Why Use Structured Formatting"
- John Crider
["Structured Formatting" is a technique for prettyprinting Pascal programs. It is based on a single indented display pattern which is used to display almost all of the structured statements in a Pascal program.]

Open Forum:

79/01/30 David Barron to Andy Mickel: [Thoughts on the future of PUG prompted by Open Letter in #13. PUG has succeeded beyond all reasonable expectation because it has been informal and unconventional.]

79/03/12 Paul Brainerd to Andy Mickel: [Understands the time to produce Pascal News and we should pick a new editor carefully and perhaps be realistic about price.]

79/03/19 John Earl Crider to Andy Mickel: [Pascal News has become an impressive journal that ... I am sure serves most other PUG members as their major link to Pascal developments.]

79/03/19 John Eisenberg to Andy Mickel: [The Bald Organization--An Anti-Constitution For Pascal User's Group]

79/05/01 Jim Miner to Friends of PUG: [Save the PUG! What is PUG? On the Proposed Constitution. Where Now, PUG?]

79/05/12 Rich Stevens to Jim Miner: [I agree with Save the PUG. Would rather see a smaller , more frequent publication.]

79/05/18 Arthur Sale to Jim Miner: [I agree with Save the PUG. Constitution would effectively eliminate international cooperation by ignoring it.]

79/05/20 David Barron to PUG membership: [I agree with Save the PUG. The only real function of PUG is to publish Pascal News.]

79/05/11 Gregg Marshall to Andy Mickel: [I oppose any movements which advocate dissolution, or radical change from the current editorial policies.]

79/05/30 Bill Heidebrecht to Andy Mickel: [PUG must be kept alive, independent, and international--it has not outlived its usefulness.]

78/09/30 Tom King to Andy Mickel: [Use of Pascal on an AM-100 system in Winnemucca, Nevada with varied applications]

78/11/02 John Eisenberg to Andy Mickel: [Arguments over the use of Pascal and Pascal Standards and extensions.]

78/10/16 Robert Cailliau to Andy Mickel: [Comments on Pascal News #12 standards and extensions.]

78/10/22 C. Roads to Andy Mickel: [Pascal in Music applications in the Computer Music journal.]

78/11/07 Laurent O. Gelinier to Andy Mickel: [Applications on a large file processor and intelligent terminals network]

78/11/08 Eugene Miya to Andy Mickel: [Jet Propulsion Labs and Pascal on their 300 computers: the Deep Space Network and need for validation programs.]

78/11/27 Paul Lebreton to Andy Mickel: [News on the Motorola 68000 and Pascal and Bus standards and other hardware conventions.]

78/11/21 Sergei Pokrovsky to Andy Mickel: [Use of a double-variant node in Pascal used to create a syntax for graph structures.]

79/03/26 Bill Marshall to Andy Mickel: [Deviations in 4 compilers for TRUNC and ROUND]

79/02/09 Curt Hill to Andy Mickel: [Pascal at the University of Nebraska: good report on the Stanford 360/370 compiler.]

79/03/08 James Cameron to Andy Mickel: [The problems of extensions might be solved by also providing a superset language "PascalII"]

79/03/13 Roger Gulbranson to Andy Mickel: [Reply to Richard Cichelli's claim that complex numbers are easy to create in Pascal. Probably need an Operator declaration]

79/04/30 B. J. Smith to Andy Mickel: [The production of various Software Tools in Pascal by Interactive Technology INC. including a DBMS and business applications.]

79/07/20 Peter Humble to Andy Mickel: [Need for conformant arrays in Pascal for numerical applications]

79/06/05 George Richmond to Andy Mickel: [Pascal at Storage Technology Corp. Errors in the Pascal-P compiler.]

79/06/07 Bob Schor to PUG: [Pascal at Rockefeller University and on PDP-11's]

79/06/29 Jack Dodds to Tony Addyman: [The need for conformant arrays in Pascal for the use of libraries and a better definition of EXTERNAL]

79/09/20 Andy Mickel to Ken Bowles: [Pascal-P is public-domain software and UCSD Pascal is based on Pascal-P, yet Improper modification history and credit is made.]

Pascal Standards.

Progress Report by Jim Miner, with help from Tony Addyman, Andy Mickel, Bill Price and Arthur Sale. Progress of the BSI/ISO standard. Standards activity in the United States. Other National Standards Efforts. ANSI charter documents for 2 committees.

Report of the ANSI X3J9 meeting in Washington by Richard Cichelli. Lots of politics.

Statement by Niklaus Wirth supporting the ISO Standards activity by Tony Addyman.

79/03/19 News Release by CBEMA on behalf of ANSI regarding the solicitation of public comments on the ISO draft standard for Pascal.

79/08/31 Experiences at the Boulder, Colorado meeting of IEEE/X3J9 committee by Andy Mickel. More politics.

Validation Suite.

Announcement by Arthur Sale of the distribution centers and prices for the forthcoming Pascal Validation Suite.

Implementation Notes:
Portable Pascals: Pascal-P, Pascal-E. Pascal Variants: Tiny Pascal, Pascal-S, Pascal-I, Concurrent Pascal, MODULA, Pascal-Plus. Hardware Notes: Pascal Machines. Feature Implementation Notes: Comment on Lazy I/O; Wish list to implementors; Note to all implementors; The for statement. Checklist. Machine-Dependent Implementations: Apple II, BESM-6, Burroughs B5700, CDC 6000/Cyber 70,170 Data General Eclipse, DEC PDP-11, LSI-11, Digico Micro 16E, Facom 230-45S, GEC 4082, Honeywell Level6, Level 66, IBM Series 1, IBM 360/370, ICL 1900, Intel 8080,8085, 8086, MODCOMP II/IV, Norsk Data NORD-10, Perkin Elmer 7/16, 3220, RCA 1802, SWTP 6800, Sperry V77, TRS-80, TI-9900, Zilog A-80.

Pascal News #16, October, 1979, Pascal User's Group, University of Minnesota Computer Center, 305 pages (155 numbered pages), edited by Andy Mickel.

Editor's Contribution: A special issue devoted to the Pascal Validation Suite. Rick Shaw is new editor of Pascal News; Thanks to everyone. How we put together an issue of Pascal News. Final thoughts on the PUG phenomenon. Greetings from the new editor and predictions of the next two issues.

The Pascal Validation Suite. Introduction to the special issue by Arthur Sale. Aims and Methods of the Validation Suite. Version 2.2 of the Validation Suite. Distribution Information, Distribution tape format and addresses. "A Pascal Processor Validation Suite" by Brian A. Wichmann and Arthur H. J. Sale. Listing of the 300+ test programs. Four Sample Validation Reports: introduction, UC B6700 compiler, Tas B6700 compiler, OMSI PDP-11 compiler, Pascal-P4 compiler. Stamp out bugs T-Shirt.

PUG FINANCES 1978-1979 (Actually through 79/12/12 just before transfer to Atlanta)

Here are the details for PUG(USA)'s finances for the 78-79 academic year. We have not included PUG(UK) because they will report separately. PUG(AUS) never has reported.

PUG(USA) Summary of Accounts:

Income:

$ 196.53	1977-78 Surplus
334.94	1976-77 Surplus (forgot to include on 77-78 accounting!)
197.20	Interest on Bank Account
87.30	Contributions
5130.00	Sale of 513 sets of backissues (9..12) @ $10
66.00	Sale of 33 miscellaneous backissues (5..8) @ $2
132.00	Sale of 44 miscellaneous backissues (9..14) @ $3
2500.00	625 subscriptions @ $4
10950.00	1825 subscriptions @ $6
$19593.97	Total income.

Expenses:

$ 181.00	People who still owe us money (bounced checks)
104.91	Mailing SIGPLAN meeting notices
319.45	Advance printing #14 - 200 copies
1541.00	Printing #14 - 3000 copies
3538.92	Printing #13 - 3000 copies
4650.95	Printing #15 - 4000 copies
6050.55	Printing #16 - 4000 copies
122.86	Postage due from returned issues
414.76	Postage #13
307.96	Postage #14
534.65	Postage #15
629.02	Postage #16
34.27	Miscellaneous photocopying costs, postage
50.48	UPS shipping of the files to Atlanta from Minneapolis
935.24	PUG(UK) 1977-78 rebate
784.90	Reprinting #12 - 500 copies
$20200.92	Total expenditure. Excess expenditure = $606.95

An attempt to assess the financial health of PUG:

Assets:

$ 2988.86	Bank Account
1930.43	Computer Center Account
7000.00	Cash sent to Atlanta to start up
4448.50	Face value of 3566 backissues on hand (=cost to print)
$16363.79	Total assets.

Liabilities:

$ 606.95	78-79 deficit
6858.00	79-80 subscriptions collected (132 @ $4 + 1055 @ $6)
1808.00	80-81 subscriptions collected (26 @ $4 + 284 @ $6)
830.00	81-82 subscriptions collected (11 @ $4 + 131 @ $6)
$10102.95	Total liabilities.

I claim we didn't do too bad. Since 79/12/12 we have spent almost all of the remaining cash here in Minneapolis on reprinting backissues 9..14. These details will be reported with the 79-80 report by Rick.

Andy Mickel 80/06/24.

Computer Systems Represented by the PUG Membership 1976-1979.

Here is a list of the computer systems listed on All-Purpose Coupons by the 4676 different members of Pascal User's Group from 76/03/03 through 79/11/01 (the last date for which I processed PUG memberships). Duplicate listings from the same people on different (renewal, change of address, etc.) coupons were eliminated.

Unfortunately I don't know all these computer systems so I may have many misplaced (alphabetically by manufacturer); check through the whole list if you are looking for a system in particular.

As PUG member A. J. Sutton so aptly stated on his 78/10/15 coupon: "cheers, but what does this [computer system(s)] mean? Owned? Operated? Programmed? Designed? Delivered? Desired?" I guess I meant using, so take these figures with a grain of salt!

Andy Mickel 80/06/24.

(Note: the notation (+n) indicates additional quantity for micros under a different name.)

1	ACOS-800
1	AIM/65
1	ALGO 2100
18	Alpha Micro AM-100
6	Altos ASC-8000
1	AMC System 29
52	Amdahl 470
1	American Microsystems S6800
1	AMTELCO
1	Andromeda
36	Apple II
1	Astrocom S760
2	Basin-4
1	BESM-6
1	Beta WS-1000
1	Billings 8080
1	BTI-4000
2	BTI-8000
19	Burroughs B1700/1800
5	Burroughs B2700
14	Burroughs B3700/3800-B4700/4800
6	Burroughs B5500/5700
79	Burroughs B6700/6800-B7700/7800
21	CDC 1700/Cyber 18
15	CDC 3000
562	CDC 6000,7000/Cyber 70,170
6	CDC Cyber 200/Star-100
1	CDC MP-32
3	CDC MP-60
3	CDC Omega 480
1	CII Iris 50
3	CII Iris 80/10070
6	Commodore Pet
2	Computer Automation 216
7	Computer Automation LSI-2
6	Computer Automation LSI-4
3	Comten (NCR)
1	COSMAC ELF
1	CPS-03 (M6800)
17	Cray Research CRAY-1
5	Cromemco Z-80
2	CTL Modular One
16	Data-100 (Northern Telecom) 78
132	Data General 600/Nova + microNova
74	Data General Eclipse
13	Datapoint
32	DEC PDP-8
746	DEC PDP-11
95	DEC LSI-11 (+114)
2	DEC PDP-15
59	DEC VAX 11/780
189	DECsystem 10
61	DECsystem 20
1	Diehl/CTM
3	Dietz MINCAL 621
9	Digital Group Z-80
1	Digital System SD3
1	Dynabyte DB 8/1
2	ECD Micromind
1	ES-1022
2	Exidy Sorcerer Z-80
2	Ferranti Argus 700
7	Four-Phase Systems
2	Foxboro FOX-1
1	Fujitsu FACOM M190
5	Fujitsu FACOM 230
1	Futuredata Z-80
1	Galaxy 5
2	General Automation 18/30
1	General Automation 100
5	General Automation 220
10	General Automation 440
7	GEC 4080
1	Gimix 6800
2	GOLEM B
1	GRI System 99
7	Harris 4/6
6	Harris S135
8	Harris S200
5	Harris S500
7	Heathkit H-8
15	Heathkit H-11

16	Hewlett Packard 1000
30	Hewlett Packard 2000/2100
23	Hewlett Packard 21MX
80	Hewlett Packard 3000
1	HEX-29
4	Hitachi 8000
1	Honeywell H316
77	Honeywell Level 6
63	Honeywell 6000/Level 66/68
11	IBM Series 1
5	IBM System 3
7	IBM System 32/34
14	IBM 1130
430	IBM System 360/370
36	IBM 3030
2	IBM 4330
44	ICL 1900
23	ICL 2900
2	ILLIAC IV
1	IMSAI VDP 40
6	IMSAI VDP 80
31	IMSAI 8080/8085
118	Intel 8080 (+73)
16	Intel 8085 (+5)
18	Intel 8086
16	Itel (National) AS 456
2	Ithaca Audio
1	ITT 1652
1	ITT 2020
1	Jacquail J-100
8	KIM-1
1	LEC-16
2	Lockheed Sue
3	Manchester MU-5
1	Marinchip 9900
1	MDS-800
1	MEMBRAIN
2	Microdata 32/5
1	Microdata 1630
2	MITS Altair 680
17	MITS Altair 8800
1	MITS Altair Z-80
2	Mitsubishi MELCOM 7700
4	3M Linolex
15	MODCOMP II
9	MODCOMP IV
14	Mostek 6502 (+44)
67	Motorola 6800 (+10)
10	Motorola 6809
8	Motorola 68000
4	Nanodata QM-1
2	National Semiconductor S-400
4	National Semiconductor 2900
4	National Semiconductor PACE
16	NCR Century
10	NCR 8000
1	NEAC-900
1	NEAC-3200
14	Norsk Data NORD-10
19	North Star Horizon (Z-80)
5	Northwest Micro 85/P
1	Odell System 85
11	Ohio Scientific Challenger
2	Ontel OP-1
1	PDS-4
1	Pertec PCC XL40
8	Pertec PCC 2000
45	Perkin Elmer Interdata 7/16
30	Perkin Elmer Interdata 7/32
1	Perkin Elmer Interdata 8/16
28	Perkin Elmer Interdata 8/32
7	Perkin Elmer 3200
4	Polymorphics 88
11	Prime P-300
34	Prime P-400
4	Prime P-500
12	Processor Technology SOL-20
1	Quasar 6800
1	Quotron 801
20	Radio Shack TRS-80
1	RCA 301
5	RCA 1802
1	Rockwell 6502
3	ROLM 1600
1	RP-16
2	SBC 80/20
20	Systems Engineering SEL 32
3	Systems Engineering SEL 8600
1	SEMS SOLAR
1	SEMS T1600
5	Siemens 4000
8	Siemens 7000
1	Singer GP-4B
1	Singer Librascope
2	Singer System 10
1	SORD M-222
2	SPC-16
1	Sperry SDP-175
5	SWTP 6800
2	Sycor (Northern Telecom) 445
6	Tandem 16
1	TDL Z-80
1	TDS-8 (Z-80)
7	Tektronix 8002
3	Telefunken 80
2	Telefunken TR-440
67	Terak 8510
3	Three Rivers PERQ
10	Texas Instruments 980
53	Texas Instruments 990
19	Texas Instruments 9900
5	Texas Instruments ASC
1	Texas Instruments DX-10
1	Time Machine TM-600
1	Univac 418
32	Univac 90/9000
156	Univac 1100
36	Univac V70/77
3	Univac UYK-7
3	Vector Graphics MZ
2	Wang WPS-30
2	Wang WPS-40
2	Wang 928
1	Wang 2200
36	Western Digital Microengine
12	Xerox (Honeywell) 560
2	Xerox (Honeywell) Sigma 3
4	Xerox (Honeywell) Sigma 5
11	Xerox (Honeywell) Sigma 6
16	Xerox (Honeywell) Sigma 7
1	Xerox (Honeywell) Sigma 8
10	Xerox (Honeywell) Sigma 9
3	Xitan Z-80
176	Zilog Z-80 (+78)
2	Zilog Z-8000
53	unspecified microprocessors

Applications

Corrections for Xref program. Pascal News #17

```
**************************************************
  1)  XREF.PAS;1
  464        LinesOnPage := LinesPerPage;   MoveToIndx := 0 (* compress table *)
  465        for TblIndx := 0 to HashTblSize - 1 do
***************
  2)  XREF.PAS;2
  464        MoveToIndx := 0 (* compress table *);
  465        for TblIndx := 0 to HashTblSize - 1 do
**************************************************
  1)  XREF.PAS;1
 1156      OutputSection := listing;   scan;   OutputSection := idents;
 1157      DumpTables;   writeln(tty, '- End CrossRef');   writeln(tty, ' ');
***************
  2)  XREF.PAS;2
 1156      LinesOnPage := LinesPerPage;
 1157      OutputSection := listing;   scan;   OutputSection := idents;
 1158      LinesOnPage := LinesPerPage;
 1159      DumpTables;   writeln(tty, '- End CrossRef');   writeln(tty, ' ');

    2 DIFFERENCES FOUND
LP:=DP1:XREF.PAS;1,DP1:XREF.PAS;2
```

All occurences of ChrCatagory should be changed to ChrCategory.

```
program pascals(input, output, tty);

{   Author: N. Wirth, E.T.H. CH-8092 Zurich, 1.3.76 }

{   Pascal-s: compiler and interpreter for a subset of Pascal    }

{
 * Purpose:
     This program compiles and interprets Pascal programs which
     are written in a subset of standard Pascal called Pascal-s.

 * Editors:
     R. J. Cichelli with corrections and enhancements from D. Baccus.

 * References:
     Niklaus Wirth,  "PASCAL-S: A subset and it's implementation",
                     Institut fur Informatik, Eidgenossische
                     Technische Hochschule,  Zuerich (1975).

 * Method:
     Recursive decent compilation into stack code for internal
     stack machine interpreter.

 * Input:
     Pascal-s source programs and input data for them.

 * Output:
     Listing and execution results (post mortum dump on errors.)

 * Limitations:
     THE LANGUAGE PASCAL-S  (by N. Wirth)
          The choice of features to be included in the subset now
     called  PASCAL-S  was  mainly  guided  by  the  contents  of
     traditional introductory programming courses.   Beyond  this
     it   is  subject  to  personal  experience,  judgement,  and
     prejudice.  A firm guideline was provided by the demand that
     the system must process a strict subset of PASCAL, i.e. that
     every PASCAL-S  program  must  also  be  acceptable  by  the
     compiler  of  Standard PASCAL without being subjected to the
     slightest change.  This rule makes it possible for  students
     to  switch  over  to  the  regular  system  in later courses
     "without noticing".  A language's power  and  its  range  of
     applications largely depend on its data types and associated
     operators.   They  also  determine  the  amount  of   effort
     required  to  master  a  language.  PASCAL-S adheres in this
     respect largely to the tradition of ALGOL 60.  Its primitive
     data  types  are  the  integers,  the  real numbers, and the
     Boolean  truth  values.   They  are  augmented  in  a   most
     important and crucial way by the type char, representing the
     available set of printable characters.  Omitted from  PASCAL
     are the scalar types and subrange types.


          PASCAL-S included only two kinds  of  data  structures:
     the  array  and  the record (without variants).  Omitted are
     the set and the file structure.  The exceptions are the  two
     standard  textfiles  input  and  output  which are declared
     implicitly (but must be listed in the program  heading).   A
     very  essential omission is the absence of pointer types and
     thereby of all dynamic  structures.   Of  course,  also  all
     packing options (packed records, packed arrays) are omitted.

          The choice of data  types  and  structures  essentially
     determines the complexity of a processing system.  Statement
     and control structures contribute but little to it.   Hence,
     PASCAL-S  includes  most  of  PASCAL's  statement structures
     (compound,   conditional,   selective,   and    repetetive
     statements).   The  only omissions are the with and the goto
     statements.   The  latter  was  omitted  very   deliberately
     because  of  the  principal  use of PASCAL-S in teaching the
     systematic design of well-structured programs.   Procedures
     and  functions  are  included in their full generality.  The
     only exception is that procedures and  functions  cannot  be
     used as parameters.

 * Computer system:
     Pascal-s was origionally installed on the CDC 6000 systems at
     E.T.H.  The program was modified to compile on DEC PDP 11's
     using the Swedish Compiler.
     Scalar types were added using Don Baccus' changes.

 }

 {$W- no warning messages  }
 {$R- no runtime testing    }


label
  99 {  abort target  };

const
  nkw = 27 {  no. of key words  };
  alng = 10 {  no. of significant chars in identifiers  };
  llng = 120 {  input line length  };
  emax = 38 {  max exponent of real numbers  };
  emin = - 38 {  min exponent  };
  kmax = 15 {  max no. of significant digits  };
  tmax = 100 {  size of table  };
  bmax = 20 {  size of block-table  };
  amax = 30 {  size of array-table  };
  c2max = 20 {  size of real constant table  };
  csmax = 30 {  max no. of cases  };
  cmax = 500 {  size of code  };
  lmax = 7 {  maximum level  };
  smax = 300 {  size of string-table  };
  ermax = 58 {  max error no.  };
  omax = 64 {  highest order code  };
  xmax = 32767;
  nmax = 32767;
  lineleng = 132 {  output line length  };
  linelimit = 132 {  maximum output line size   };
  stacksize = 600 {   run-time stack size  };

type
  symbol =
    (intcon, realcon, charcon, string, notsy, plus, minus, times, idiv,
     rdiv, imod, andsy, orsy, eql, neq, gtr, geq, lss, leq, lparent,
     rparent, lbrack, rbrack, comma, semicolon, period, colon, becomes,
     constsy, typesy, varsy, functionsy, proceduresy, arraysy, recordsy,
     programsy, ident, beginsy, ifsy, casesy, repeatsy, whilesy, forsy,
     endsy, elsesy, untilsy, ofsy, dosy, tosy, downtosy, thensy);
  index = - xmax .. + xmax;
  alfa = packed array [1 .. alng] of char;
  object =
    (konstant, variable, type1, prozedure, funktion);
  types =
    (notyp, ints, reals, bools, chars, arrays, records, scalars);
  symset = set of symbol;
  typset = set of types;
  item = record
           typ: types;
           ref: index
         end;
  order = packed record
                   f: - omax .. + omax;
                   x: - lmax .. + lmax;
                   y: - nmax .. + nmax
                 end;

var
  sy: symbol {  last symbol read by insymbol  };
  id: alfa {  identifier from insymbol  };
  inum: integer {  integer from insymbol  };
  rnum: real {  real number from insymbol  };
  sleng: integer {  string length  };
  ch: char {  last character read from source program  };
  line: array [1 .. llng] of char;
  cc: integer {  character counter  };
  lc: integer {  program location counter  };
  ll: integer {  length of current line  };
  errs: set of 0 .. ermax;
  errpos: integer;
  progname: alfa;
  iflag, oflag, skipflag: boolean;
  constbegsys, typebegsys, blockbegsys, facbegsys, statbegsys: symset;
  key: array [1 .. nkw] of alfa;
  ksy: array [1 .. nkw] of symbol;
  sps: array [char] of symbol {  special symbols  };
  t, a, b, sx, c1, c2: integer {  indices to tables  };
  stantyps: typset;
  display: array [0 .. lmax] of integer;
  tab: array [0 .. tmax] of {  identifier table  }
                          packed record
                                   name: alfa;
                                   link: index;
                                   obj: object;
                                   typ: types;
                                   ref: index;
                                   normal: boolean;
                                   lev: 0 .. lmax;
                                   adr: integer
                                 end;
  atab: array [1 .. amax] of {  array-table  }
                        packed record
                                 inxtyp, eltyp: types;
                                 elref, low, high, elsize, size: index
                               end;
  btab: array [1 .. bmax] of {  block-table  }
                        packed record
                                 last, lastpar, psize, vsize: index
                               end;
  stab: packed array [0 .. smax] of char {  string table  };
  rconst: array [1 .. c2max] of real;
  code: array [0 .. cmax] of order;


procedure abend;

  begin
    {  goto 99  }
{  }  halt
  end;


procedure errormsg;

  var
    k: integer;
    msg: array [0 .. ermax] of alfa;

  begin
    msg[0] := 'undef id  ';   msg[1] := 'multi def ';
    msg[2] := 'identifier';   msg[3] := 'program   ';
    msg[4] := ')         ';   msg[5] := ':         ';
    msg[6] := 'syntax    ';   msg[7] := 'ident, var';
    msg[8] := 'of        ';   msg[9] := '(         ';
    msg[10] := 'id, array ';   msg[11] := '[         ';
    msg[12] := ']         ';   msg[13] := '..        ';
    msg[14] := ';         ';   msg[15] := 'func. type';
    msg[16] := '=         ';   msg[17] := 'boolean   ';
    msg[18] := 'convar typ';   msg[19] := 'type      ';
    msg[20] := 'prog.param';   msg[21] := 'too big   ';
    msg[22] := '.         ';   msg[23] := 'typ (case)';
    msg[24] := 'character ';   msg[25] := 'const id  ';
    msg[26] := 'index type';   msg[27] := 'indexbound';
    msg[28] := 'no array  ';   msg[29] := 'type id   ';
    msg[30] := 'undef type';   msg[31] := 'no record ';
    msg[32] := 'boole type';   msg[33] := 'arith type';
    msg[34] := 'integer   ';   msg[35] := 'types     ';
    msg[36] := 'param type';   msg[37] := 'variab id ';
    msg[38] := 'string    ';  msg[39] := 'no.of pars';
    msg[40] := 'type      ';  msg[41] := 'type      ';
    msg[42] := 'real type ';  msg[43] := 'integer   ';
    msg[44] := 'var, const';  msg[45] := 'var, proc ';
    msg[46] := 'types (:=)';  msg[47] := 'typ (case)';
    msg[48] := 'type      ';  msg[49] := 'store ovfl';
    msg[50] := 'constant  ';  msg[51] := ':=        ';
    msg[52] := 'then      ';  msg[53] := 'until     ';
    msg[54] := 'do        ';  msg[55] := 'to downto ';
    msg[56] := 'begin     ';  msg[57] := 'end       ';
    msg[58] := 'factor    ';  k := 0;   writeln;
    writeln(' key words');
    while errs <> [] do
      begin
        while not (k in errs) do k := k + 1;   writeln(k, '  ', msg[k]);
        errs := errs - [k]
      end
  end { errormsg };


procedure endskip;

  begin {  underline skipped part of input  }
    while errpos < cc do begin write('-');   errpos := errpos + 1 end;
    skipflag := false
  end {  endskip  };


procedure nextch {  read next character; process line end  };


  function uppercase(ch: char): char;

    begin
      if (ch >= 'a') and (ch <= 'z')
      then
        uppercase := chr(ord(ch) - ord('a') + ord('A'))
         {  ASCII case conversion routine ... EBCDIC requires a
           more elaborate test  }
      else uppercase := ch
    end { uppercase };


  begin {  nextch  }
    if cc = ll
    then
      begin
        if eof(input) then
          begin
            writeln;   writeln(' program incomplete');   errormsg;
            abend;
          end;
        if errpos <> 0 then
          begin if skipflag  then endskip;   writeln;   errpos := 0
          end;
        write(lc: 5, '  ');   ll := 0;   cc := 0;
        while not eoln(input) do
          begin ll := ll + 1;   read(ch);   write(ch);   line[ll] := ch
          end;
        writeln;   ll := ll + 1;   read(line[ll])
      end;
    cc := cc + 1;   ch := uppercase(line[cc]);
  end {  nextch  };


procedure error(n: integer);

  begin
    if errpos = 0   then write(' ****');
    if cc > errpos then
      begin
        write(' ': cc - errpos, '^', n: 2);   errpos := cc + 3;
        errs := errs + [n]
      end
  end {  error  };


procedure fatal(n: integer);

  var
    msg: array [1 .. 7] of alfa;

  begin
    writeln;   errormsg;   msg[1] := 'identifier';
    msg[2] := 'procedures';   msg[3] := 'reals     ';
    msg[4] := 'arrays    ';   msg[5] := 'levels    ';
    msg[6] := 'code      ';   msg[7] := 'strings   ';
    writeln(' compiler table for ', msg[n], ' is too small');
    abend {  terminate compilation  }
  end {  fatal  };

{ ------------------------------------------------------------insymbol- }


procedure insymbol {  reads next symbol  };

  label
    1, 2, 3;

  var
    i, j, k, e: integer;


  procedure readscale;

    var
      s, sign: integer;

    begin
      nextch;   sign := 1;   s := 0;
      if ch = '+'   then nextch
      else if ch = '-'   then begin nextch;   sign := - 1 end;
      while ch in ['0' .. '9'] do
        begin s := 10 * s + ord(ch) - ord('0');   nextch end;
      e := s * sign + e
    end {  readscale  };


  procedure adjustscale;

    var
      s: integer;
      d, t: real;

    begin
      if k + e > emax   then error(21)
      else
        if k + e < emin   then rnum := 0.0
        else
          begin
            s := abs(e);   t := 1.0;   d := 10.0;
            repeat
              while not odd(s) do begin s := s div 2;   d := sqr(d) end;
              s := s - 1;   t := d * t
            until s = 0;
            if e >= 0   then rnum := rnum * t   else rnum := rnum / t
          end
    end {  adjustscale  };


  begin {  insymbol  }
 1: while ch = ' ' do nextch;
    if ch in ['A' .. 'Z']
    then
      begin {  identifier or wordsymbol  }
        k := 0;   id := '          ';
        repeat
          if k < alng   then begin k := k + 1;   id[k] := ch end;
          nextch
        until not (ch in ['A' .. 'Z', '0' .. '9']);
        i := 1;   j := nkw;
        {  binary search  }
        repeat
          k := (i + j) div 2;   if id <= key[k]   then j := k - 1;
          if id >= key[k]   then i := k + 1
        until i > j;
        if i - 1 > j   then sy := ksy[k]   else sy := ident
      end
    else
      if ch in ['0' .. '9']
      then
        begin {  number  }
          k := 0;   inum := 0;   sy := intcon;
          repeat
            inum := inum * 10 + ord(ch) - ord('0');   k := k + 1;
            nextch
          until not (ch in ['0' .. '9']);
          if (k > kmax) or (inum > nmax)
          then begin error(21);   inum := 0;   k := 0 end;
          if ch = '.'
          then
            begin
              nextch;
              if ch = '.'   then ch := ':'
              else
                begin
                  sy := realcon;   rnum := inum;   e := 0;
                  while ch in ['0' .. '9'] do
                    begin
                      e := e - 1;
                      rnum := 10.0 * rnum + (ord(ch) - ord('0'));
                      nextch
                    end;
                  if ch = 'E'   then readscale;
                  if e <> 0   then adjustscale
                end
            end
          else
            if ch = 'E' then
              begin
                sy := realcon;   rnum := inum;   e := 0;   readscale;
                if e <> 0   then adjustscale
              end;
        end
      else
        case ch of
          ':':
            begin
              nextch;
              if ch = '='   then begin sy := becomes;   nextch end
              else sy := colon
            end;
          '<':
            begin
              nextch;
              if ch = '='   then begin sy := leq;   nextch end
              else
                if ch = '>'   then begin sy := neq;   nextch end
                else sy := lss
            end;
          '>':
            begin
              nextch;
              if ch = '='   then begin sy := geq;   nextch end
              else sy := gtr
            end;
          '.':
            begin
              nextch;
              if ch = '.'   then begin sy := colon;   nextch end
              else sy := period
            end;
          '''':
            begin
              k := 0;   2: nextch;
              if ch = ''''
              then begin nextch;  if ch <> ''''  then goto 3 end;
              if sx + k = smax  then fatal(7);  stab[sx + k] := ch;
              k := k + 1;
              if cc = 1  then begin {  end of line  } k := 0; end
              else goto 2;
           3: if k = 1
              then begin sy := charcon;  inum := ord(stab[sx]) end
              else
                if k = 0
                then begin error(38);  sy := charcon;  inum := 0 end
                else
                  begin
                    sy := string;  inum := sx;  sleng := k;
                    sx := sx + k
                  end
            end;
          '(':
            begin
              nextch;
              if ch <> '*'  then sy := lparent
              else
                begin {  comment  }
                  nextch;
                  repeat while ch <> '*' do nextch;  nextch
                  until ch = ')';
                  nextch;  goto 1
                end
            end;
          '+', '-', '*', '/', ')', '=', ',', '[', ']', ';':
            begin sy := sps[ch];  nextch end;
          '$', '^', '}', '`', '"', '{', '%', '@', '\':
            begin error(24);  nextch;  goto 1 end
        end
  end {  insymbol  };

{ ---------------------------------------------------------- enter --- }


procedure enter(x0: alfa; x1: object; x2: types; x3: integer);

  begin
    t := t + 1;
      {  enter standard identifier  }
    with tab[t] do
      begin
        name := x0;  link := t - 1;  obj := x1;  typ := x2;
        ref := 0;  normal := true;  lev := 0;  adr := x3
      end
  end {  enter  };


procedure enterarray(tp: types; l, h: integer);

  begin
    if l > h  then error(27);
    if (abs(l) > xmax) or (abs(h) > xmax)
    then begin error(27);  l := 0;  h := 0; end;
    if a = amax  then fatal(4)
    else
      begin
        a := a + 1;
        with atab[a] do begin inxtyp := tp;  low := l;  high := h end
      end
  end {  enterarray  };


procedure enterblock;

  begin
    if b = bmax  then fatal(2)
    else
      begin b := b + 1;  btab[b].last := 0;  btab[b].lastpar := 0 end
  end {  enterblock  };


procedure enterreal(x: real);

  begin
    if c2 = c2max - 1  then fatal(3)
    else
      begin
        rconst[c2 + 1] := x;  c1 := 1;
        while rconst[c1] <> x do c1 := c1 + 1;
        if c1 > c2  then c2 := c1
      end
  end {  enterreal  };


procedure emit(fct: integer);

  begin
    if lc = cmax  then fatal(6);  code[lc].f := fct;  lc := lc + 1
  end {  emit  };


procedure emit1(fct, b: integer);

  begin
    if lc = cmax  then fatal(6);
    with code[lc] do begin f := fct;  y := b end;  lc := lc + 1
  end {  emit1  };


procedure emit2(fct, a, b: integer);

  begin
    if lc = cmax  then fatal(6);
    with code[lc] do begin f := fct;  x := a;  y := b end;
    lc := lc + 1
  end {  emit2  };


procedure printtables;

  var
    i: integer;
    o: order;

  begin
    writeln;
    writeln(' identifiers          link  obj  typ  ref  nrm  lev  adr');
    for i := btab[1].last + 1 to t do
      with tab[i] do
        writeln(i, ' ', name, link: 5, ord(obj): 5, ord(typ): 5, ref: 5,
           ord(normal): 5, lev: 5, adr: 5);
    writeln;  writeln(' blocks    last lpar psze vsze');
    for i := 1 to b do
      with btab[i] do
        writeln(i, last: 5, lastpar: 5, psize: 5, vsize: 5);
    writeln;  writeln(' arrays    xtyp etyp eref  low high elsz size');
    for i := 1 to a do
      with atab[i] do
        writeln(i, ord(inxtyp): 5, ord(eltyp): 5, elref: 5, low: 5, high
          : 5, elsize: 5, size: 5);
    writeln;  writeln(' code:');
    for i := 0 to lc - 1 do
      begin
        if i mod 5 = 0  then begin writeln;  write(i: 5) end;
        o := code[i];  write(o.f: 5);
        if o.f < 31
        then
          if o.f < 4  then write(o.x: 2, o.y: 5)  else write(o.y: 7)
        else write('            ');
        write(',')
      end;
    writeln
  end {  printtables  };

{ ------------------------------------------------------------block-- }


procedure block(fsys: symset; isfun: boolean; level: integer);

  type
    conrec = record
               rf: integer;
               case tp: types of
                 ints, chars, bools, scalars: (i: integer);
                 reals: (r: real)
             end;

  var
    dx: integer {  data allocation index  };
    prt: integer {  t-index of this procedure  };
    prb: integer {  b-index of this procedure  };
    x: integer;


  procedure skip(fsys: symset; n: integer);

    begin
      error(n);  skipflag := true;
      while not (sy in fsys) do insymbol;  if skipflag  then endskip
    end {  skip  };


  procedure test(s1, s2: symset; n: integer);

    begin if not (sy in s1)  then skip(s1 + s2, n) end {  test  };


  procedure testsemicolon;

    begin
      if sy = semicolon  then insymbol
      else
        begin error(14);  if sy in [comma, colon]  then insymbol end;
      test([ident] + blockbegsys, fsys, 6)
    end {  testsemicolon  };


  procedure enter(id: alfa; k: object);

    var
      j, l: integer;

    begin
      if t = tmax  then fatal(1)
      else
        begin
          tab[0].name := id;  j := btab[display[level]].last;  l := j;
          while tab[j].name <> id do j := tab[j].link;
          if j <> 0  then error(1)
          else
            begin
              t := t + 1;
              with tab[t] do
                begin
                  name := id;  link := l;  obj := k;  typ := notyp;
                  ref := 0;  lev := level;  adr := 0
                end;
              btab[display[level]].last := t
            end
        end
  end {  enter  };


function loc(id: alfa): integer;

  var
    i, j: integer;

  begin {  locate id in table  }
    i := level;   tab[0].name := id {  sentinel  };
    repeat
      j := btab[display[i]].last;
      while tab[j].name <> id do j := tab[j].link;   i := i - 1;
    until (i < 0) or (j <> 0);
    if j = 0  then error(0);   loc := j
  end {  loc  };


procedure entervariable;

  begin
    if sy = ident   then begin enter(id, variable);   insymbol end
    else error(2)
  end {  entervariable  };


procedure constant(fsys: symset; var c: conrec);

  var
    x, sign: integer;

  begin
    c.tp := notyp;   c.i := 0;   c.rf := 0;
    test(constbegsys, fsys, 50);
    if sy in constbegsys
    then
      begin
        if sy = charcon
        then begin c.tp := chars;   c.i := inum;   insymbol end
        else
          begin
            sign := 1;
            if sy in [plus, minus] then
              begin if sy = minus   then sign := - 1;   insymbol end;
            if sy = ident
            then
              begin
                x := loc(id);
                if x <> 0
                then
                  if tab[x].obj <> konstant   then error(25)
                  else
                    begin
                      c.tp := tab[x].typ;   c.rf := tab[x].ref;
                      if c.tp = reals
                      then c.r := sign * rconst[tab[x].adr]
                      else
                        begin
                          if (c.tp <> ints) and (sign = - 1)
                          then error(50);
                          c.i := sign * tab[x].adr
                        end
                    end;
                insymbol
              end
            else
              if sy = intcon
              then
                begin c.tp := ints;   c.i := sign * inum;   insymbol
                end
              else
                if sy = realcon
                then
                  begin
                    c.tp := reals;   c.r := sign * rnum;   insymbol
                  end
                else skip(fsys, 50)
          end;
        test(fsys, [], 6)
      end
  end {  constant  };


procedure typ(fsys: symset; var tp: types; var rf, sz: integer);

  var
    x: integer;
    eltp: types;
    elrf: integer;
    elsz, offset, t0, t1: integer;


  procedure arraytyp(var aref, arsz: integer);

    var
      itscalar: boolean;
      eltp: types;
      low, high: conrec;
      elrf, elsz, i: integer;

    begin
      itscalar := false;
      if sy = ident then
        begin
          i := loc(id);
          itscalar := (tab[i].obj = type1) and (tab[i].typ = scalars)
        end;
      if not itscalar
      then
        begin
          constant([colon, rbrack, rparent, ofsy] + fsys, low);
          if low.tp = reals
          then begin error(27);   low.tp := ints;   low.i := 0 end;
          if sy = colon   then insymbol   else error(13);
          constant([rbrack, comma, rparent, ofsy] + fsys, high);
          if (high.tp <> low.tp) or (high.rf <> low.rf)
          then begin error(27);   high.i := low.i end;
        end
      else
        with tab[i] do
          begin
            insymbol;   low.tp := typ;   low.i := 0;
            high.i := tab[ref].adr
          end;
      enterarray(low.tp, low.i, high.i);   aref := a;
      if sy = comma
      then
        begin insymbol;   eltp := arrays;   arraytyp(elrf, elsz) end
      else
        begin
          if sy = rbrack   then insymbol
          else begin error(12);   if sy = rparent   then insymbol end;
          if sy = ofsy   then insymbol   else error(8);
          typ(fsys, eltp, elrf, elsz)
        end;
      with atab[aref] do
        begin
          arsz := (high - low + 1) * elsz;   size := arsz;
          eltyp := eltp;   elref := elrf;   elsize := elsz
        end;
    end {  arraytyp  };


  begin {  typ  }
    tp := notyp;   rf := 0;   sz := 0;   test(typebegsys, fsys, 10);
    if sy in typebegsys
    then
      begin
        if sy = ident
        then
          begin
            x := loc(id);
            if x <> 0 then
              with tab[x] do
                if obj <> type1   then error(29)
                else
                  begin
                    tp := typ;   rf := ref;   sz := adr;
                    if tp = notyp   then error(30)
                  end;
            insymbol
          end
        else
          if sy = arraysy
          then
            begin
              insymbol;
              if sy = lbrack   then insymbol
              else
                begin error(11);   if sy = lparent   then insymbol
                end;
              tp := arrays;   arraytyp(rf, sz)
            end
          else
            if sy = lparent {  scalar types  }
            then
              begin
                sz := 0;   t0 := t;
                repeat
                  insymbol;
                  if sy <> ident   then error(2)
                  else
                    begin
                      enter(id, konstant);
                      with tab[t] do
                        begin
                          adr := sz;   ref := rf;   typ := scalars
                        end;
                      sz := sz + 1;   insymbol
                    end
                until sy <> comma;
                if sy = rparent   then insymbol   else error(4);
                while t0 < t do
                  begin t0 := t0 + 1;   tab[0].ref := t end;
                rf := t;   sz := 1;   tp := scalars
              end
            else
              begin {  records  }
                insymbol;   enterblock;   tp := records;   rf := b;
                if level = lmax   then fatal(5);   level := level + 1;
                display[level] := b;   offset := 0;
                while sy <> endsy do
                  begin {  field section  }
                    if sy = ident
                    then
                      begin
                        t0 := t;   entervariable;
                        while sy = comma do
                          begin insymbol;   entervariable end;
                        if sy = colon   then insymbol   else error(5);
                        t1 := t;
                        typ(fsys + [semicolon, endsy, comma, ident],
                          eltp, elrf, elsz);
                        while t0 < t1 do
                          begin
                            t0 := t0 + 1;
                            with tab[t0] do
                              begin
                                typ := eltp;   ref := elrf;
                                normal := true;   adr := offset;
                                offset := offset + elsz
                              end
                          end
                      end;
                    if sy <> endsy then
                      begin
                        if sy = semicolon   then insymbol
                        else
                          begin
                            error(14);
                            if sy = comma   then insymbol
                          end;
                        test([ident, endsy, semicolon], fsys, 6)
                      end
                  end;
                btab[rf].vsize := offset;   sz := offset;
                btab[rf].psize := 0;   insymbol;   level := level - 1
              end;
        test(fsys, [], 6)
      end
  end {  typ  };


procedure parameterlist {  formal parameter list  };

  var
    tp: types;
    rf, sz, x, t0: integer;
    valpar: boolean;

  begin
    insymbol;   tp := notyp;   rf := 0;   sz := 0;
    test([ident, varsy], fsys + [rparent], 7);
    while sy in [ident, varsy] do
      begin
        if sy <> varsy   then valpar := true
        else begin insymbol;   valpar := false end;
        t0 := t;   entervariable;
        while sy = comma do begin insymbol;   entervariable; end;
        if sy = colon
        then
          begin
            insymbol;
            if sy <> ident   then error(2)
            else
              begin
                x := loc(id);   insymbol;
                if x <> 0 then
                  with tab[x] do
                    if obj <> type1   then error(29)
                    else
                      begin
                        tp := typ;   rf := ref;
                        if valpar   then sz := adr   else sz := 1
                      end;
              end;
            test([semicolon, rparent], [comma, ident] + fsys, 14)
          end
        else error(5);
        while t0 < t do
          begin
            t0 := t0 + 1;
            with tab[t0] do
              begin
                typ := tp;   ref := rf;   normal := valpar;
                adr := dx;   lev := level;   dx := dx + sz
              end
          end;
        if sy <> rparent
        then
          begin
            if sy = semicolon   then insymbol
            else begin error(14);   if sy = comma   then insymbol end;
            test([ident, varsy], [rparent] + fsys, 6)
          end
      end {  while  };
    if sy = rparent
    then begin insymbol;   test([semicolon, colon], fsys, 6) end
    else error(4)
  end {  parameterlist  };


procedure constantdeclaration;

  var
    c: conrec;

  begin
    insymbol;   test([ident], blockbegsys, 2);
    while sy = ident do
      begin
        enter(id, konstant);   insymbol;
        if sy = eql   then insymbol
        else begin error(16);   if sy = becomes   then insymbol end;
        constant([semicolon, comma, ident] + fsys, c);
        tab[t].typ := c.tp;   tab[t].ref := 0;
        if c.tp = reals
        then begin enterreal(c.r);   tab[t].adr := c1 end
        else tab[t].adr := c.i;
        testsemicolon
      end
  end {  constantdeclaration  };


procedure typedeclaration;

  var
    tp: types;
    rf, sz, t1: integer;

  begin
    insymbol;   test([ident], blockbegsys, 2);
    while sy = ident do
      begin
        enter(id, type1);   t1 := t;   insymbol;
        if sy = eql   then insymbol
        else begin error(16);   if sy = becomes   then insymbol end;
        typ([semicolon, comma, ident] + fsys, tp, rf, sz);
        with tab[t1] do begin typ := tp;   ref := rf;   adr := sz end;
        testsemicolon
      end
  end {  typedeclaration  };


procedure variabledeclaration;

  var
    t0, t1, rf, sz: integer;
    tp: types;

  begin
    insymbol;
    while sy = ident do
      begin
        t0 := t;   entervariable;
        while sy = comma do begin insymbol;   entervariable; end;
        if sy = colon   then insymbol   else error(5);   t1 := t;
        typ([semicolon, comma, ident] + fsys, tp, rf, sz);
        while t0 < t1 do
          begin
            t0 := t0 + 1;
            with tab[t0] do
              begin
                typ := tp;   ref := rf;   lev := level;   adr := dx;
                normal := true;   dx := dx + sz
              end
          end;
        testsemicolon
      end
  end {  variabledeclaration  };


procedure procdeclaration;

  var
    isfun: boolean;

  begin
    isfun := sy = functionsy;   insymbol;
    if sy <> ident   then begin error(2);   id := '          ' end;
    if isfun   then enter(id, funktion)   else enter(id, prozedure);
    tab[t].normal := true;   insymbol;
    block([semicolon] + fsys, isfun, level + 1);
    if sy = semicolon   then insymbol   else error(14);
    emit(32 + ord(isfun)) {  exit  }
  end {  proceduredeclaration  };

{ ---------------------------------------------------------statement-- }


procedure statement(fsys: symset);

  var
    i: integer;
    x: item;


  procedure expression(fsys: symset; var x: item);
    forward;


  procedure selector(fsys: symset; var v: item);

    var
      x: item;
      a, j: integer;

    begin {  sy in [lparent, lbrack, period]  }
      repeat
        if sy = period
        then
          begin
            insymbol;
            {  field selector  }
            if sy <> ident   then error(2)
            else
              begin
                if v.typ <> records   then error(31)
                else
                  begin {  search field identifier  }
                    j := btab[v.ref].last;   tab[0].name := id;
                    while tab[j].name <> id do j := tab[j].link;
                    if j = 0   then error(0);   v.typ := tab[j].typ;
                    v.ref := tab[j].ref;   a := tab[j].adr;
                    if a <> 0   then emit1(9, a)
                  end;
                insymbol
              end
          end
        else
          begin {  array selector  }
            if sy <> lbrack   then error(11);
            repeat
              insymbol;   expression(fsys + [comma, rbrack], x);
              if v.typ <> arrays   then error(28)
              else
                begin
                  a := v.ref;
                  if atab[a].inxtyp <> x.typ   then error(26)
                  else
                  if atab[a].elsize = 1   then emit1(20, a)
                  else emit1(21, a);
                v.typ := atab[a].eltyp;   v.ref := atab[a].elref
              end
          until sy <> comma;
          if sy = rbrack   then insymbol
          else
            begin error(12);   if sy = rparent   then insymbol end
        end
    until not (sy in [lbrack, lparent, period]);
    test(fsys, [], 6)
  end {  selector  };


procedure call(fsys: symset; i: integer);

  var
    x: item;
    lastp, cp, k: integer;

  begin
    emit1(18, i) {  mark stack  };
    lastp := btab[tab[i].ref].lastpar;   cp := i;
    if sy = lparent
    then
      begin {  actual parameter list  }
        repeat
          insymbol;
          if cp >= lastp   then error(39)
          else
            begin
              cp := cp + 1;
              if tab[cp].normal
              then
                begin {  value parameter  }
                  expression(fsys + [comma, colon, rparent], x);
                  if x.typ = tab[cp].typ
                  then
                    begin
                      if x.ref <> tab[cp].ref   then error(36)
                      else
                        if x.typ = arrays
                        then emit1(22, atab[x.ref].size)
                        else
                          if x.typ = records
                          then emit1(22, btab[x.ref].vsize)
                    end
                  else
                    if (x.typ = ints) and (tab[cp].typ = reals)
                    then emit1(26, 0)
                    else if x.typ <> notyp   then error(36);
                end
              else
                begin {  variable parameter  }
                  if sy <> ident   then error(2)
                  else
                    begin
                      k := loc(id);   insymbol;
                      if k <> 0
                      then
                        begin
                          if tab[k].obj <> variable
                          then error(37);
                          x.typ := tab[k].typ;
                          x.ref := tab[k].ref;
                          if tab[k].normal
                          then emit2(0, tab[k].lev, tab[k].adr)
                          else emit2(1, tab[k].lev, tab[k].adr);
                          if sy in [lbrack, lparent, period] then
                            selector(fsys + [comma, colon, rparent],
                               x);
                          if (x.typ <> tab[cp].typ) or (x.ref <> tab
                             [cp].ref)
                          then error(36)
                        end
                    end
                end
            end;
          test([comma, rparent], fsys, 6)
        until sy <> comma;
        if sy = rparent   then insymbol   else error(4)
      end;
    if cp < lastp   then error(39) {  too few actual parameters  };
    emit1(19, btab[tab[i].ref].psize - 1);
    if tab[i].lev < level   then emit2(3, tab[i].lev, level)
  end {  call  };


function resulttype(a, b: types): types;

  begin
    if (a > reals) or (b > reals)
    then begin error(33);   resulttype := notyp end
    else
      if (a = notyp) or (b = notyp)   then resulttype := notyp
      else
        if a = ints
        then
          if b = ints   then resulttype := ints
          else begin resulttype := reals;   emit1(26, 1) end
        else
          begin
            resulttype := reals;   if b = ints   then emit1(26, 0)
          end
  end {  resulttype  };


procedure expression;

  var
    y: item;
    op: symbol;


  procedure simpleexpression(fsys: symset; var x: item);

    var
      y: item;
      op: symbol;


    procedure term(fsys: symset; var x: item);

      var
        y: item;
        op: symbol;
        ts: typset;


      procedure factor(fsys: symset; var x: item);

        var
          i, f: integer;


        procedure standfct(n: integer);

          var
            ts: typset;

          begin {  standard function no. n  }
            if sy = lparent   then insymbol   else error(9);
            if n < 17
            then
              begin
                expression(fsys + [rparent], x);
                case n of
                  0, 2:
                    begin {  abs, sqrt  }
                      ts := [ints, reals];   tab[i].typ := x.typ;
                      if x.typ = reals   then n := n + 1
                    end;
                  4, 5: ts := [ints] {  odd, chr  };
                  6: ts := [ints, bools, chars, scalars] {  ord  };
                  7, 8:
                    begin
                      ts := [ints, bools, chars, scalars]
                         {  succ, pred  };
                      tab[i].typ := x.typ
                    end;
                  9, 10, 11, 12, 13, 14, 15, 16:
                     {  round,trunc,sin,cos,... }
                    begin
                      ts := [ints, reals];
                      if x.typ = ints   then emit1(26, 0)
                    end
                end;
                if x.typ in ts   then emit1(8, n)
                else if x.typ <> notyp   then error(48);
              end
            else {  eof,eoln  }
              begin {  n in [17,18]  }
                if sy <> ident   then error(2)
                else
                  if id <> 'INPUT     '   then error(0)
                  else insymbol;
                emit1(8, n);
              end;
            x.typ := tab[i].typ;
            if sy = rparent   then insymbol   else error(4)
          end {  standfct  };


        begin {  factor  }
          x.typ := notyp;   x.ref := 0;   test(facbegsys, fsys, 58);
          while sy in facbegsys do
            begin
              if sy = ident
              then
                begin
                  i := loc(id);   insymbol;
                  with tab[i] do
                    case obj of
                      konstant:
                        begin
                          x.typ := typ;   x.ref := 0;
                          if x.typ = reals   then emit1(25, adr)
                          else emit1(24, adr)
                        end;
                      variable:
                        begin
                          x.typ := typ;   x.ref := ref;
                          if sy in [lbrack, lparent, period]
                          then
                            begin
                              if normal   then f := 0   else f := 1;
                              emit2(f, lev, adr);
                              selector(fsys, x);
                              if x.typ in stantyps   then emit(34)
                            end
                          else
                            begin
                              if x.typ in stantyps
                              then
                                if normal   then f := 1
                                else f := 2
                              else
                                if normal   then f := 0
                                else f := 1;
                              emit2(f, lev, adr)
                          end
                      end;
                    type1, prozedure: error(44);
                    funktion:
                      begin
                        x.typ := typ;
                        if lev <> 0   then call(fsys, i)
                        else standfct(adr)
                      end
                  end {  case,with  }
              end
            else
              if sy in [charcon, intcon, realcon]
              then
                begin
                  if sy = realcon
                  then
                    begin
                      x.typ := reals;   enterreal(rnum);
                      emit1(25, c1)
                    end
                  else
                    begin
                      if sy = charcon   then x.typ := chars
                      else x.typ := ints;
                      emit1(24, inum)
                    end;
                  x.ref := 0;   insymbol
                end
              else
                if sy = lparent
                then
                  begin
                    insymbol;   expression(fsys + [rparent], x);
                    if sy = rparent   then insymbol
                    else error(4)
                  end
                else
                  if sy = notsy then
                    begin
                      insymbol;   factor(fsys, x);
                      if x.typ = bools   then emit(35)
                      else if x.typ <> notyp   then error(32)
                    end;
            test(fsys, facbegsys, 6)
          end {  while  }
      end {  factor  };


    begin {  term  }
      factor(fsys + [times, rdiv, idiv, imod, andsy], x);
      while sy in [times, rdiv, idiv, imod, andsy] do
        begin
          op := sy;   insymbol;
          factor(fsys + [times, rdiv, idiv, imod, andsy], y);
          if op = times
          then
            begin
              x.typ := resulttype(x.typ, y.typ);
              case x.typ of
                notyp:;
                ints: emit(57);
                reals: emit(60)
              end
            end
          else
            if op = rdiv
            then
              begin
                if x.typ = ints
                then begin emit1(26, 1);   x.typ := reals end;
                if y.typ = ints
                then begin emit1(26, 0);   y.typ := reals end;
                if (x.typ = reals) and (y.typ = reals)
                then emit(61)
                else
                  begin
                    if (x.typ <> notyp) and (y.typ <> notyp)
                    then error(33);
                    x.typ := notyp
                  end
              end
            else
              if op = andsy
              then
                begin
                  if (x.typ = bools) and (y.typ = bools)
                  then emit(56)
                  else
                    begin
                      if (x.typ <> notyp) and (y.typ <> notyp)
                      then error(32);
                      x.typ := notyp
                    end
                end
              else
                begin {  op in [idiv,imod]  }
                  if (x.typ = ints) and (y.typ = ints)
                  then
                    if op = idiv   then emit(58)   else emit(59)
                  else
                    begin
                      if (x.typ <> notyp) and (y.typ <> notyp)
                      then error(34);
                      x.typ := notyp
                    end
                end
        end
    end {  term  };


    begin {  simpleexpression  }
      if sy in [plus, minus]
      then
        begin
          op := sy;   insymbol;   term(fsys + [plus, minus], x);
          if x.typ > reals   then error(33)
          else
            if op = minus
            then if x.typ = reals   then emit(64)   else emit(36)
        end
      else term(fsys + [plus, minus, orsy], x);
      while sy in [plus, minus, orsy] do
        begin
          op := sy;   insymbol;
          term(fsys + [plus, minus, orsy], y);
          if op = orsy
          then
            begin
              if (x.typ = bools) and (y.typ = bools)
              then emit(51)
              else
                begin
                  if (x.typ <> notyp) and (y.typ <> notyp)
                  then error(32);
                  x.typ := notyp
                end
            end
          else
            begin
              x.typ := resulttype(x.typ, y.typ);
              case x.typ of
                notyp:;
                ints: if op = plus   then emit(52)   else emit(53);
                reals: if op = plus   then emit(54)   else emit(55)
              end
            end
        end
    end {  simpleexpression  };


  begin {  expression  }
    simpleexpression(fsys + [becomes, eql, neq, lss, leq, gtr, geq],
       x);
    if sy in [becomes, eql, neq, lss, leq, gtr, geq]
    then
      begin
        if sy = becomes   then begin error(6);   op := eql end
        else op := sy;
        insymbol;   simpleexpression(fsys, y);
        if (x.typ in [notyp, ints, bools, chars, scalars]) and (x.
          typ = y.typ) and (x.ref = y.ref)
        then
          case op of
            eql: emit(45);
            neq: emit(46);
            lss: emit(47);
            leq: emit(48);
            gtr: emit(49);
            geq: emit(50)
          end
        else
          begin
            if x.typ = ints
            then begin x.typ := reals;   emit1(26, 1) end
            else
              if y.typ = ints
              then begin y.typ := reals;   emit1(26, 0) end;
            if (x.typ = reals) and (y.typ = reals)
            then
              case op of
                eql: emit(39);
                neq: emit(40);
                lss: emit(41);
                leq: emit(42);
                gtr: emit(43);
                geq: emit(44)
              end
            else error(35)
          end;
        x.typ := bools
      end
  end {  expression  };


procedure assignment(lv, ad: integer);

  var
    x, y: item;
    f: integer;
    {  tab[i].obj in [variable,prozedure]  }

  begin
    x.typ := tab[i].typ;   x.ref := tab[i].ref;
    if tab[i].normal   then f := 0   else f := 1;
    emit2(f, lv, ad);
    if sy in [lbrack, lparent, period]
    then selector([becomes, eql] + fsys, x);
    if sy = becomes   then insymbol
    else begin error(51);   if sy = eql   then insymbol end;
    expression(fsys, y);
    if x.typ = y.typ
    then
      if x.typ in stantyps   then emit(38)
      else
        if x.ref <> y.ref   then error(46)
        else
          if x.typ = arrays   then emit1(23, atab[x.ref].size)
          else emit1(23, btab[x.ref].vsize)
    else
```

```
      if (x.typ = reals) and (y.typ = ints)
      then begin emit1(26, 0);   emit(38) end
      else
        if (x.typ <> notyp) and (y.typ <> notyp)   then error(46)
  end {  assignment  };


procedure compoundstatement;

  begin
    insymbol;   statement([semicolon, endsy] + fsys);
    while sy in [semicolon] + statbegsys do
      begin
        if sy = semicolon   then insymbol   else error(14);
        statement([semicolon, endsy] + fsys)
      end;
    if sy = endsy   then insymbol   else error(57)
  end {  compoundstatemenet  };


procedure ifstatement;

  var
    x: item;
    lc1, lc2: integer;

  begin
    insymbol;   expression(fsys + [thensy, dosy], x);
    if not (x.typ in [bools, notyp])   then error(17);   lc1 := lc;
    emit(11) { jmpc };
    if sy = thensy   then insymbol
    else begin error(52);   if sy = dosy   then insymbol end;
    statement(fsys + [elsesy]);
    if sy = elsesy
    then
      begin
        insymbol;   lc2 := lc;   emit(10);   code[lc1].y := lc;
        statement(fsys);   code[lc2].y := lc
      end
    else code[lc1].y := lc
  end {  ifstatement  };


procedure casestatement;

  var
    x: item;
    i, j, k, lc1: integer;
    casetab: array [1 .. csmax] of packed record
                                         val, lc: index
                                       end;
    exittab: array [1 .. csmax] of integer;


  procedure caselabel;

    var
      lab: conrec;
      k: integer;

    begin
      constant(fsys + [comma, colon], lab);
      if (lab.tp <> x.typ) or (lab.rf <> x.ref)   then error(47)
      else
        if i = csmax   then fatal(6)
        else
          begin
            i := i + 1;   k := 0;   casetab[i].val := lab.i;
            casetab[i].lc := lc;
            repeat k := k + 1   until casetab[k].   val = lab.i;
            if k < i   then error(1) {  multiple definition  };
          end
    end {  caselabel  };


  procedure onecase;

    begin
      if sy in constbegsys
      then
        begin
          caselabel;
          while sy = comma do begin insymbol;   caselabel end;
          if sy = colon   then insymbol   else error(5);
          statement([semicolon, endsy] + fsys);   j := j + 1;
          exittab[j] := lc;   emit(10)
        end
    end {  onecase  };


  begin {  casestatement  }
    insymbol;   i := 0;   j := 0;
    expression(fsys + [ofsy, comma, colon], x);
    if not (x.typ in [ints, bools, chars, notyp, scalars])
    then error(23);
    lc1 := lc;   emit(12) {  jmpx  };
    if sy = ofsy   then insymbol   else error(8);   onecase;
    while sy = semicolon do begin insymbol;   onecase end;
    code[lc1].y := lc;
    for k := 1 to i do
      begin emit1(13, casetab[k].val);   emit1(13, casetab[k].lc)
      end;
    emit1(10, 0);   for k := 1 to j do code[exittab[k]].y := lc;
    if sy = endsy   then insymbol   else error(57)
  end {  casestatement  };


procedure repeatstatement;

  var
    x: item;
    lc1: integer;

  begin
    lc1 := lc;   insymbol;   statement([semicolon, untilsy] + fsys);
    while sy in [semicolon] + statbegsys do
      begin
        if sy = semicolon   then insymbol   else error(14);
        statement([semicolon, untilsy] + fsys)
      end;
    if sy = untilsy
    then
      begin
        insymbol;   expression(fsys, x);
        if not (x.typ in [bools, notyp])   then error(17);
        emit1(11, lc1)
      end
    else error(53)
  end {  repeatstatement  };


procedure whilestatement;

  var
    x: item;
    lc1, lc2: integer;

  begin
    insymbol;   lc1 := lc;   expression(fsys + [dosy], x);
    if not (x.typ in [bools, notyp])   then error(17);   lc2 := lc;
    emit(11);   if sy = dosy   then insymbol   else error(54);
    statement(fsys);   emit1(10, lc1);   code[lc2].y := lc
  end {  whilestatement  };


procedure forstatement;

  var
    cvt: types;
    cvr: integer;
    x: item;
    i, f, lc1, lc2: integer;

  begin
    insymbol;
    if sy = ident
    then
      begin
        i := loc(id);   insymbol;
        if i = 0   then begin cvt := ints;   cvr := 0 end
        else
          if tab[i].obj = variable
          then
            begin
              cvt := tab[i].typ;   cvr := tab[i].ref;
              if not tab[i].normal   then error(37)
              else emit2(0, tab[i].lev, tab[i].adr);
              if not (cvt in [notyp, ints, bools, chars, scalars])
              then error(18)
            end
          else begin error(37);   cvt := ints;   cvr := 0 end
      end
    else skip([becomes, tosy, downtosy, dosy] + fsys, 2);
    if sy = becomes
    then
      begin
        insymbol;   expression([tosy, downtosy, dosy] + fsys, x);
        if (x.typ <> cvt) and (x.ref <> cvr)   then error(19);
      end
    else skip([tosy, downtosy, dosy] + fsys, 51);
    f := 14;
    if sy in [tosy, downtosy]
    then
      begin
        if sy = downtosy   then f := 16;   insymbol;
        expression([dosy] + fsys, x);
        if (x.typ <> cvt) and (x.ref <> cvr)   then error(19)
      end
    else skip([dosy] + fsys, 55);
    lc1 := lc;   emit(f);
    if sy = dosy   then insymbol   else error(54);   lc2 := lc;
    statement(fsys);   emit1(f + 1, lc2);   code[lc1].y := lc
  end {  forstatement  };


procedure standproc(n: integer);

  var
    i, f: integer;
    x, y: item;

  begin
    case n of
      1, 2:
        begin {  read  }
          if not iflag   then begin error(20);   iflag := true end;
          if sy = lparent
          then
            begin
              repeat
                insymbol;
                if sy <> ident   then error(2)
                else
                  begin
                    i := loc(id);   insymbol;
                    if i <> 0
                    then
                      if tab[i].obj <> variable   then error(37)
                      else
                        begin
```

```
                              x.typ := tab[i].typ;
                              x.ref := tab[i].ref;
                              if tab[i].normal   then f := 0
                              else f := 1;
                              emit2(f, tab[i].lev, tab[i].adr);
                              if sy in [lbrack, lparent, period]
                              then selector(fsys + [comma, rparent], x);
                              if x.typ in [ints, reals, chars, notyp]
                              then emit1(27, ord(x.typ))
                              else error(40)
                            end
                      end;
                    test([comma, rparent], fsys, 6);
                  until sy <> comma;
                  if sy = rparent   then insymbol   else error(4)
                end;
              if n = 2   then emit(62)
            end;
          3, 4:
            begin {  write  }
              if sy = lparent
              then
                begin
                  repeat
                    insymbol;
                    if sy = string
                    then
                      begin
                        emit1(24, sleng);   emit1(28, inum);   insymbol
                      end
                    else
                      begin
                        expression(fsys + [comma, colon, rparent], x);
                        if not (x.typ in (stantyps - [scalars]))
                        then error(41);
                        if sy = colon
                        then
                          begin
                            insymbol;
                            expression(fsys + [comma, colon, rparent], y
                               );
                            if y.typ <> ints   then error(43);
                            if sy = colon
                            then
                              begin
                                if x.typ <> reals   then error(42);
                                insymbol;
                                expression(fsys + [comma, rparent], y);
                                if y.typ <> ints   then error(43);
                                emit(37)
                              end
                            else emit1(30, ord(x.typ))
                          end
                        else emit1(29, ord(x.typ))
                      end
                  until sy <> comma;
                  if sy = rparent   then insymbol   else error(4)
                end;
              if n = 4   then emit(63)
            end
        end {  case  }
      end {  standproc  };


    begin {  statement  }
      if sy in statbegsys + [ident]
      then
        case sy of
          ident:
            begin
              i := loc(id);   insymbol;
              if i <> 0
              then
                case tab[i].obj of
                  konstant, type1: error(45);
                  variable: assignment(tab[i].lev, tab[i].adr);
                  prozedure:
                    if tab[i].lev <> 0   then call(fsys, i)
                    else standproc(tab[i].adr);
                  funktion:
                    if tab[i].ref = display[level]
                    then assignment(tab[i].lev + 1, 0)
                    else error(45)
                end
            end;
          beginsy: compoundstatement;
          ifsy: ifstatement;
          casesy: casestatement;
          whilesy: whilestatement;
          repeatsy: repeatstatement;
          forsy: forstatement
        end;
      test(fsys, [], 14)
    end {  statement  };


  begin {  block  }
    dx := 5;   prt := t;   if level > lmax   then fatal(5);
    test([lparent, colon, semicolon], fsys, 14);   enterblock;
    display[level] := b;   prb := b;   tab[prt].typ := notyp;
    tab[prt].ref := prb;
    if (sy = lparent) and (level > 1)   then parameterlist;
    btab[prb].lastpar := t;   btab[prb].psize := dx;
    if isfun
    then
      if sy = colon
      then
        begin
          insymbol {  function type  };
          if sy = ident
          then
            begin
              x := loc(id);   insymbol;
              if x <> 0 then
                if tab[x].obj <> type1   then error(29)
                else
                  if tab[x].typ in stantyps
                  then tab[prt].typ := tab[x].typ
                  else error(15)
            end
          else skip([semicolon] + fsys, 2)
        end
      else error(5);
    if sy = semicolon   then insymbol   else error(14);
    repeat
      if sy = constsy   then constantdeclaration;
      if sy = typesy   then typedeclaration;
      if sy = varsy   then variabledeclaration;   btab[prb].vsize := dx;
      while sy in [proceduresy, functionsy] do procdeclaration;
      test([beginsy], blockbegsys + statbegsys, 56)
    until sy in statbegsys;
    tab[prt].adr := lc;   insymbol;
    statement([semicolon, endsy] + fsys);
    while sy in [semicolon] + statbegsys do
      begin
        if sy = semicolon   then insymbol   else error(14);
        statement([semicolon, endsy] + fsys)
      end;
    if sy = endsy   then insymbol   else error(57);
    test(fsys + [period], [], 6)
  end {  block  };

{ -------------------------------------------------------interpret--- }


procedure interpret;
{  global code, tab, btab  }

  label
     98     {   Wirth used a 'trap label' (non-standard) here
     to catch run time errors.  See notes for alternate solution.  };

  var
    ir: order {  instruction buffer  };
    pc: integer {  program counter  };
    ps:
      (run, fin, caschk, divchk, inxchk, stkchk, linchk, lngchk, redchk)
       ;
    t: integer {  top stack index  };
    b: integer {  base index  };
    lncnt, ocnt, blkcnt, chrcnt: integer {  counters  };
    h1, h2, h3, h4: integer;
    fld: array [1 .. 4] of integer {  default field widths  };
    display: array [1 .. lmax] of integer;
    s: array [1 .. stacksize] of          {  blockmark:                  }
                  record
                    case types of        {    s[b+0] = fct result    }
                      ints: (i: integer);
                                         {    s[b+1] = return adr    }
                      reals: (r: real);
                                         {    s[b+2] = static link   }
                      bools: (b: boolean);
                                         {    s[b+3] = dynamic link }
                      chars: (c: char)   {    s[b+4] = table index   }
                  end;

  begin {  interpret  }
    s[1].i := 0;   s[2].i := 0;   s[3].i := - 1;
    s[4].i := btab[1].last;   b := 0;   display[1] := 0;
    t := btab[2].vsize - 1;   pc := tab[s[4].i].adr;   ps := run;
    lncnt := 0;   ocnt := 0;   chrcnt := 0;   fld[1] := 10;
    fld[2] := 22;   fld[3] := 10;   fld[4] := 1;
    repeat
      ir := code[pc];   pc := pc + 1;
      if ocnt < maxint   then ocnt := ocnt + 1;
      case ir.f of
        0:
          begin {  load address  }
            t := t + 1;
            if t > stacksize   then ps := stkchk
            else s[t].i := display[ir.x] + ir.y
          end;
        1:
          begin {  load value  }
            t := t + 1;
            if t > stacksize   then ps := stkchk
            else s[t] := s[display[ir.x] + ir.y]
          end;
        2:
          begin {  load indirect  }
            t := t + 1;
            if t > stacksize   then ps := stkchk
            else s[t] := s[s[display[ir.x] + ir.y].i]
          end;
        3:
          begin {  update display  }
            h1 := ir.y;   h2 := ir.x;   h3 := b;
            repeat
              display[h1] := h3;   h1 := h1 - 1;   h3 := s[h3 + 2].i
            until h1 = h2
          end;
        8:
          case ir.y of
            0: s[t].i := abs(s[t].i);
            1: s[t].r := abs(s[t].r);
            2: s[t].i := sqr(s[t].i);
            3: s[t].r := sqr(s[t].r);
            4: s[t].b := odd(s[t].i);
            5:
              begin {  s[t].c := chr(s[t].i);  }
        if (s[t].i < 0) or (s[t].i > 127)   then ps := inxchk
      end;
    6: {  s[t].i := ord(s[t].c)  };
    7: s[t].c := succ(s[t].c);
    8: s[t].c := pred(s[t].c);
    9: s[t].i := round(s[t].r);
    10: s[t].i := trunc(s[t].r);
    11: s[t].r := sin(s[t].r);
    12: s[t].r := cos(s[t].r);
    13: s[t].r := exp(s[t].r);
    14: s[t].r := ln(s[t].r);
    15: s[t].r := sqrt(s[t].r);
    16: s[t].r := arctan(s[t].r);
    17:
      begin
        t := t + 1;
        if t > stacksize   then ps := stkchk
        else s[t].b := eof(input)
      end;
    18:
      begin
        t := t + 1;
        if t > stacksize   then ps := stkchk
        else s[t].b := eoln(input)
      end
  end;
9: s[t].i := s[t].i + ir.y { offset };
10: pc := ir.y {  jump  };
11:
  begin {  conditional jump  }
    if not s[t].b   then pc := ir.y;   t := t - 1
  end;
12:
  begin {  switch  }
    h1 := s[t].i;   t := t - 1;   h2 := ir.y;   h3 := 0;
    repeat
      if code[h2].f <> 13
      then begin h3 := 1;   ps := caschk end
      else
        if code[h2].y = h1
        then begin h3 := 1;   pc := code[h2 + 1].y end
        else h2 := h2 + 2
    until h3 <> 0
  end;
14:
  begin {  for1up  }
    h1 := s[t - 1].i;
    if h1 <= s[t].i   then s[s[t - 2].i].i := h1
    else begin t := t - 3;   pc := ir.y end
  end;
15:
  begin {  for2up  }
    h2 := s[t - 2].i;   h1 := s[h2].i + 1;
    if h1 <= s[t].i
    then begin s[h2].i := h1;   pc := ir.y end
    else t := t - 3;
  end;
16:
  begin {  for1down  }
    h1 := s[t - 1].i;
    if h1 >= s[t].i   then s[s[t - 2].i].i := h1
    else begin pc := ir.y;   t := t - 3 end
  end;
17:
  begin {  for2down  }
    h2 := s[t - 2].i;   h1 := s[h2].i - 1;
    if h1 >= s[t].i
    then begin s[h2].i := h1;   pc := ir.y end
    else t := t - 3;
  end;
18:
  begin {  mark stack  }
    h1 := btab[tab[ir.y].ref].vsize;
    if t + h1 > stacksize   then ps := stkchk
    else
      begin
        t := t + 5;   s[t - 1].i := h1 - 1;   s[t].i := ir.y
      end
  end;
19:
  begin {  call  }
    h1 := t - ir.y {  h1 points to base  };
    h2 := s[h1 + 4].i { h2 points to tab };   h3 := tab[h2].lev;
    display[h3 + 1] := h1;   h4 := s[h1 + 3].i + h1;
    s[h1 + 1].i := pc;   s[h1 + 2].i := display[h3];
    s[h1 + 3].i := b;   for h3 := t + 1 to h4 do s[h3].i := 0;
    b := h1;   t := h4;   pc := tab[h2].adr
  end;
20:
  begin {  index1  }
    h1 := ir.y { h1 points to atab };   h2 := atab[h1].low;
    h3 := s[t].i;
    if h3 < h2   then ps := inxchk
    else
      if h3 > atab[h1].high   then ps := inxchk
      else begin t := t - 1;   s[t].i := s[t].i + (h3 - h2) end
  end;
21:
  begin {  index  }
    h1 := ir.y { h1 points to atab };   h2 := atab[h1].low;
    h3 := s[t].i;
    if h3 < h2   then ps := inxchk
    else
      if h3 > atab[h1].high   then ps := inxchk
      else
        begin
          t := t - 1;
          s[t].i := s[t].i + (h3 - h2) * atab[h1].elsize
        end
  end;
22:
  begin {  load block  }
    h1 := s[t].i;   t := t - 1;   h2 := ir.y + t;
    if h2 > stacksize   then ps := stkchk
    else
      while t < h2 do
        begin t := t + 1;   s[t] := s[h1];   h1 := h1 + 1 end
  end;
23:
  begin {  copy block  }
    h1 := s[t - 1].i;   h2 := s[t].i;   h3 := h1 + ir.y;
    while h1 < h3 do
      begin s[h1] := s[h2];   h1 := h1 + 1;   h2 := h2 + 1 end;
    t := t - 2
  end;
24:
  begin {  literal  }
    t := t + 1;
    if t > stacksize   then ps := stkchk   else s[t].i := ir.y
  end;
25:
  begin {  load real  }
    t := t + 1;
    if t > stacksize   then ps := stkchk
    else s[t].r := rconst[ir.y]
  end;
26: begin {  float  } h1 := t - ir.y;   s[h1].r := s[h1].i end;
27:
  begin {  read  }
    if eof(input)   then ps := redchk
    else
      case ir.y of
        1: read(s[s[t].i].i);
        2: read(s[s[t].i].r);
        4: begin s[s[t].i].i := 0;   read(s[s[t].i].c) end
      end;
    t := t - 1
  end;
28:
  begin {  write string  }
    h1 := s[t].i;   h2 := ir.y;   t := t - 1;
    chrcnt := chrcnt + h1;
    if chrcnt > lineleng   then ps := lngchk;
    repeat write(stab[h2]);   h1 := h1 - 1;   h2 := h2 + 1
    until h1 = 0
  end;
29:
  begin {  write1  }
    chrcnt := chrcnt + fld[ir.y];
    if chrcnt > lineleng   then ps := lngchk
    else
      case ir.y of
        1: write(s[t].i: fld[1]);
        2: write(s[t].r: fld[2]);
        3: write(s[t].b: fld[3]);
        4: write(chr(s[t].i mod 127 {  ASCII  }))
      end;
    t := t - 1
  end;
30:
  begin {  write2  }
    chrcnt := chrcnt + s[t].i;
    if chrcnt > lineleng   then ps := lngchk
    else
      case ir.y of
        1: write(s[t - 1].i: s[t].i);
        2: write(s[t - 1].r: s[t].i);
        3: write(s[t - 1].b: s[t].i);
        4: write(chr(s[t - 1].i mod 127 {  ASCII  }): s[t].i)
      end;
    t := t - 2
  end;
31: ps := fin;
32:
  begin {  exit procedure  }
    t := b - 1;   pc := s[b + 1].i;   b := s[b + 3].i
  end;
33:
  begin {  exit function  }
    t := b;   pc := s[b + 1].i;   b := s[b + 3].i
  end;
34: s[t] := s[s[t].i];
35: s[t].b := not s[t].b;
36: s[t].i := - s[t].i;
37:
  begin
    chrcnt := chrcnt + s[t - 1].i;
    if chrcnt > lineleng   then ps := lngchk
    else write(s[t - 2].r: s[t - 1].i: s[t].i);
    t := t - 3
  end;
38: begin {  store  } s[s[t - 1].i] := s[t];   t := t - 2 end;
39: begin t := t - 1;   s[t].b := s[t].r = s[t + 1].r end;
40: begin t := t - 1;   s[t].b := s[t].r <> s[t + 1].r end;
41: begin t := t - 1;   s[t].b := s[t].r < s[t + 1].r end;
42: begin t := t - 1;   s[t].b := s[t].r <= s[t + 1].r end;
43: begin t := t - 1;   s[t].b := s[t].r > s[t + 1].r end;
44: begin t := t - 1;   s[t].b := s[t].r >= s[t + 1].r end;
45: begin t := t - 1;   s[t].b := s[t].i = s[t + 1].i end;
46: begin t := t - 1;   s[t].b := s[t].i <> s[t + 1].i end;
47: begin t := t - 1;   s[t].b := s[t].i < s[t + 1].i end;
48: begin t := t - 1;   s[t].b := s[t].i <= s[t + 1].i end;
49: begin t := t - 1;   s[t].b := s[t].i > s[t + 1].i end;
50: begin t := t - 1;   s[t].b := s[t].i >= s[t + 1].i end;
51: begin t := t - 1;   s[t].b := s[t].b or s[t + 1].b end;
52: begin t := t - 1;   s[t].i := s[t].i + s[t + 1].i end;
53: begin t := t - 1;   s[t].i := s[t].i - s[t + 1].i end;
54: begin t := t - 1;   s[t].r := s[t].r + s[t + 1].r end;
55: begin t := t - 1;   s[t].r := s[t].r - s[t + 1].r; end;
56: begin t := t - 1;   s[t].b := s[t].b and s[t + 1].b end;
```

```
        57: begin t := t - 1;  s[t].i := s[t].i * s[t + 1].i end;
        58:
          begin
            t := t - 1;
            if s[t + 1].i = 0  then ps := divchk
            else s[t].i := s[t].i div s[t + 1].i
          end;
        59:
          begin
            t := t - 1;
            if s[t + 1].i = 0  then ps := divchk
            else s[t].i := s[t].i mod s[t + 1].i
          end;
        60: begin t := t - 1;  s[t].r := s[t].r * s[t + 1].r; end;
        61:
          begin
            t := t - 1;
            if s[t + 1].r = 0.0  then ps := divchk
            else s[t].r := s[t].r / s[t + 1].r
          end;
        62: if eof(input)  then ps := redchk  else readln;
        63:
          begin
            writeln;  lncnt := lncnt + 1;  chrcnt := 0;
            if lncnt > linelimit  then ps := linchk
          end;
        64: s[t].r := - s[t].r
      end { case };
    until ps <> run;
98: if ps <> fin
    then
      begin
        writeln;  writeln;  write(' halt at', pc: 5, ' because of ');
        case ps of
          run: writeln('error (see dayfile)');
          caschk: writeln('undefined case');
          divchk: writeln('division by 0');
          inxchk: writeln('invalid index');
          stkchk: writeln('storage overflow');
          linchk: writeln('too much output');
          lngchk: writeln('line too long');
          redchk: writeln('reading past end of file')
        end;
        h1 := b;  blkcnt := 10;
        { post mortem dump }
        repeat
          writeln;  blkcnt := blkcnt - 1;
          if blkcnt = 0  then h1 := 0;  h2 := s[h1 + 4].i;
          if h1 <> 0
          then writeln(' ', tab[h2].name, ' called at', s[h1 + 1].i: 5);
          h2 := btab[tab[h2].ref].last;
          while h2 <> 0 do
            with tab[h2] do
              begin
                if obj = variable
                then
                  if typ in stantyps
                  then
                    begin
                      write('    ', name, ' = ');
                      if normal  then h3 := h1 + adr
                      else h3 := s[h1 + adr].i;
                      case typ of
                        ints: writeln(s[h3].i);
                        reals: writeln(s[h3].r);
                        bools: writeln(s[h3].b);
                        chars:
                          writeln(chr(s[h3].i mod 127 { ASCII }))
                      end
                    end;
                h2 := link
              end;
          h1 := s[h1 + 3].i
        until h1 < 0;
      end;
    writeln;
    if ocnt = maxint  then write(' many')  else write(ocnt);
    writeln(' steps.');
  end { interpret };

{ -------------------------------------------------------------main---- }


begin { main }
  writeln(tty, '- pascals (10.2.76)');  key[1] := 'AND       ';
  key[2] := 'ARRAY     ';  key[3] := 'BEGIN     ';
  key[4] := 'CASE      ';  key[5] := 'CONST     ';
  key[6] := 'DIV       ';  key[7] := 'DO        ';
  key[8] := 'DOWNTO    ';  key[9] := 'ELSE      ';
  key[10] := 'END       ';  key[11] := 'FOR       ';
  key[12] := 'FUNCTION  ';  key[13] := 'IF        ';
  key[14] := 'MOD       ';  key[15] := 'NOT       ';
  key[16] := 'OF        ';  key[17] := 'OR        ';
  key[18] := 'PROCEDURE ';  key[19] := 'PROGRAM   ';
  key[20] := 'RECORD    ';  key[21] := 'REPEAT    ';
  key[22] := 'THEN      ';  key[23] := 'TO        ';
  key[24] := 'TYPE      ';  key[25] := 'UNTIL     ';
  key[26] := 'VAR       ';  key[27] := 'WHILE     ';  ksy[1] := andsy;
  ksy[2] := arraysy;  ksy[3] := beginsy;  ksy[4] := casesy;
  ksy[5] := constsy;  ksy[6] := idiv;  ksy[7] := dosy;
  ksy[8] := downtosy;  ksy[9] := elsesy;  ksy[10] := endsy;
  ksy[11] := forsy;  ksy[12] := functionsy;  ksy[13] := ifsy;
  ksy[14] := imod;  ksy[15] := notsy;  ksy[16] := ofsy;
  ksy[17] := orsy;  ksy[18] := proceduresy;  ksy[19] := programsy;
  ksy[20] := recordsy;  ksy[21] := repeatsy;  ksy[22] := thensy;
  ksy[23] := tosy;  ksy[24] := typesy;  ksy[25] := untilsy;
  ksy[26] := varsy;  ksy[27] := whilesy;  sps['+'] := plus;
  sps['-'] := minus;  sps['*'] := times;  sps['/'] := rdiv;
  sps['('] := lparent;  sps[')'] := rparent;  sps['='] := eql;
  sps[','] := comma;  sps['['] := lbrack;  sps[']'] := rbrack;
  sps[';'] := semicolon;
  constbegsys := [plus, minus, intcon, realcon, charcon, ident];
  typebegsys := [lparent, ident, arraysy, recordsy];
  blockbegsys := [constsy, typesy, varsy, proceduresy, functionsy,
    beginsy];
  facbegsys := [intcon, realcon, charcon, ident, lparent, notsy];
  statbegsys := [beginsy, ifsy, whilesy, repeatsy, forsy, casesy];
  stantyps := [notyp, ints, reals, bools, chars, scalars];  lc := 0;
  ll := 0;  cc := 0;  ch := ' ';  errpos := 0;  errs := [];
  {  }  reset(input, 'MYPROG.PAS',,'DP0:');
  insymbol;  t := - 1;  a := 0;
  b := 1;  sx := 0;  c2 := 0;  display[0] := 1;  iflag := false;
  oflag := false;  skipflag := false;
  if sy <> programsy  then error(3)
  else
    begin
      insymbol;
      if sy <> ident  then error(2)
      else
        begin
          progname := id;  insymbol;
          if sy <> lparent  then error(9)
          else
            repeat
              insymbol;
              if sy <> ident  then error(2)
              else
                begin
                  if id = 'INPUT     '  then iflag := true
                  else
                    if id = 'OUTPUT    '  then oflag := true
                    else error(0);
                  insymbol
                end
            until sy <> comma;
          if sy = rparent  then insymbol  else error(4);
          if not oflag  then error(20)
        end
    end;
  enter('          ', variable, notyp, 0) { sentinel };
  enter('FALSE     ', konstant, bools, 0);
  enter('TRUE      ', konstant, bools, 1);
  enter('REAL      ', type1, reals, 1);
  enter('CHAR      ', type1, chars, 1);
  enter('BOOLEAN   ', type1, bools, 1);
  enter('INTEGER   ', type1, ints, 1);
  enter('ABS       ', funktion, reals, 0);
  enter('SQR       ', funktion, reals, 2);
  enter('ODD       ', funktion, bools, 4);
  enter('CHR       ', funktion, chars, 5);
  enter('ORD       ', funktion, ints, 6);
  enter('SUCC      ', funktion, chars, 7);
  enter('PRED      ', funktion, chars, 8);
  enter('ROUND     ', funktion, ints, 9);
  enter('TRUNC     ', funktion, ints, 10);
  enter('SIN       ', funktion, reals, 11);
  enter('COS       ', funktion, reals, 12);
  enter('EXP       ', funktion, reals, 13);
  enter('LN        ', funktion, reals, 14);
  enter('SQRT      ', funktion, reals, 15);
  enter('ARCTAN    ', funktion, reals, 16);
  enter('EOF       ', funktion, bools, 17);
  enter('EOLN      ', funktion, bools, 18);
  enter('READ      ', prozedure, notyp, 1);
  enter('READLN    ', prozedure, notyp, 2);
  enter('WRITE     ', prozedure, notyp, 3);
  enter('WRITELN   ', prozedure, notyp, 4);
  enter('          ', prozedure, notyp, 0);
  with btab[1] do
    begin last := t;  lastpar := 1;  psize := 0;  vsize := 0 end;
  block(blockbegsys + statbegsys, false, 1);
  if sy <> period  then error(22);  emit(31) { halt };
  if btab[2].vsize > stacksize  then error(49);
  if progname = 'TESTO     '  then printtables;
  if errs = []
  then
    begin
      if iflag
      then
        begin
{  }      reset(input, 'MYPROG.DAT',, 'DP0:');
          if eof(input)  then writeln(' input data missing')
          else
            begin
              writeln(' (eor)') { copy input data };
              while not eof(input) do
                begin
                  write(' ');
                  while not eoln(input) do
                    begin read(ch);  write(ch) end;
                  writeln;  read(ch)
                end;
              reset(input);
            end
        end;
      writeln(' (eof)');  writeln;  interpret
    end
  else errormsg;
99: writeln
end { pascals }.
```

Notes on system dependent code in Pascal-S and Pascal-I.

by Richard J. Cichelli

Pascal-S had a 'trap label' to recover (just once) from user errors that cause aborts. In Pascal-I, John McGrath, Curt Loughin and I solved similar problems with what we think are cleaner, simpler and more generally useful techniques. We'd like to share them with you here.

```
  { Pascal-I  ... Interactive, conversational Pascal-S.
    These code fragments from Pascal-I show nearly all
    of the non-standard and/or system dependent parts
    of the 7500 line program that is Pascal-I.

    The code illustrates how functionality, which must
    be provided for the system to work in its given
    environment and obviously cannot be specified in
    a standard way, can be isolated so that reasonable
    portability can be obtained.

    Of particular note is the method for recovering from timeouts
    and user aborts.  On a user abort, Pascal-I terminates the
    user initiated action, recovers and accepts the next user
    command request.  Pascal-I also does interactive I/O.
  }

program pascali(textin, textout, input/+, output+);

  { The '/+' and '+' declare these files interactive.
    On input, the initial 'get' is supressed and on
    output, buffers can be flushed explicitly.
    If Pascal 6000 had 'Lazy I/O', then this non-standard code
    would be unnecessary.
  }

label
  1, 2, 3, { recovery labels ... targets for low level error
                                 handling routines.
             Note:  This is where you really need those gotos out
                    of procedures.
           }
  13       { terminate program on multiple aborts.
             This is so you can abort Pascal-I itself.
             (You might think that we software giants never
             code infinite loops.  Well, this is just in case
             the compiler generates bad code for perfect logic.
             Right?)
           }
```

```
 const
   .
   .          {      lots   of   these      }
   .
 type
   .
   .          {      lots   of    these      }
   .
  abortcodes =
    (timelimit, userabort);   { The types of aborts that are processed
  abortset = set of abortcodes;

var
   .
   .      {    lots   of   these    }
   .
  aborted, timeout: boolean;
  abtcnt: integer;
  lastabort: real;

procedure rename(var f: textfile; lfn: scopelfn); extern;
  {   This procedure changes scope file names by modifying
      their FETs.
      I really think this is the right way to specify the dynamic
      (run-time) association of a system file with a Pascal file.
      Overloading the reset and rewrite procedures and adding
      standards violating parameters to them seems so messy.
  }

procedure interupt(procedure inproc(reasons: abortset)); extern;
  {   This procedure arms the SCOPE system routine 'reprieve' with
      a user supplied recovery routine.  Time-outs and aborts are
      handled by this routine.  Upon interrupt, the procedure passed
      as a parameter to the interrupt routine is invoked.  After
      it executes, the program is restarted at the instruction where
      it was interrupted.  By having the interrupt routine set global
      flags, controlled recovery is possible.    }
     .
     .
     .    {  about 140 additional procedures here.
     .       all written in quite Standard Pascal.
     .
     .       Note: Pascal-I has an interpreter that is similar
     .       to that of Pascal-S.  In it, and in other procedures
     .       where the user might want to quit the actions of the
     .       program, loop terminators include a test of the
     .       aborted flag.  Since Pascal-I has control of when
     .       aborts are acted upon,  it does so only at convenient
     .       stopping places. For example, the interpreter only
     .       tests for aborts  on user program statement boundaries.
     .       The state of Pascal-I and the interpreting user
     .       program always appear well defined.  }
     .
```

```
procedure timeoutsave;
    {    This routine is called if a time out occurs.  It is called
         by the main routine if the timeout flag is set during a
         recovery.   Upon 'reprieve' invocation, enough additional
         time is allocated so that a user can save his/her program
         to a file.  After exiting Pascal-I, more time can be
         requested (with ETL) or another login session started.
         The saved file allows the user to procede from where he/she
         left off.
    }

  var
    lfn: scopelfn;

  begin
    writeln(' You are out of time.  Please enter the name of');
    writeln(' the file to which you want your program saved -');
     {    putseg(output);    flush buffer  }
    if eos(input) then getseg(input); getch;
    {  The eos (end of segment) and getseg (get segment) are
       rather unpleasent ways to interface to terminals.
       Fortunately, only a very few other places in Pascal-I
       have such code.  Porting the program usually only requires
       defining null procedures for getseg and putseg and making
       eos return false.  At one place, eos may need to be changed to
       eof.
    }
    getlfn(lfn);   rename(textout, lfn);   rewrite(textout);
    { get the file name and associate it with textout }
    saveblk(btabmax - 1, true);   reset(textout);
    { write the program to it and rewind it for next time }
  end {  timeoutsave  };


procedure intproc(reasons: abortset);
     { No Pascal procedure in Pascal-I calls this routine.
       It is invoked by the 'reprieve' service routine which
       is invoked by the system montior when a time-out or
       user abort occurs.

       Incidentally, Pascal 6000 version 2 didn't have reentrant
       system routines. (The fault of using the RJ (return jump)
       to implement the calls.)  Because this routine doesn't
       require any of the system routines to be accessed
       reentrantly, we can use a very simple version of the
       recovery routines in Pascal-I.  Pascal-I is distributed
       with fully re-entrant recovery capabilities in its systems
       routines.
     }

  const
    abtmintime = 2.0;   {   minimum time limit allowed between
                            user recoverable aborts ( 2 secs.)
                            If less, then kill Pascal-I, cause
                            he wants us dead.
                         }
    maxabtwocmd = 4;   {  maximum user aborts allowed between
                          commands.  If more then kill Pascal-I.
                       }
```

```
  var
    now: real;


  function rtime: real;
    extern {  real time clock
              Returns time in seconds, accurate to milliseconds.
           };


  begin { intproc }
    timeout := timelimit in reasons;
    aborted := userabort in reasons;
    if aborted
    then
      begin
        abtcnt := abtcnt + 1;   now := rtime;
        if now - lastabort < abtmintime
        then
          begin message('* multiple aborts.');   goto 13 {  bag it  }
          end
        else lastabort := now;
      end;
    writeln;   ich := ' ';
    { clear and restart I/O }
    if abtcnt < maxabtwocmd   then interupt(intproc);
    { Set up for the next user abort or time-out }
  end {  intproc  };


begin {  Pascal-I  - - - Main Routine   }
   .
   .
   .
   .   {  initialize     the    world   }
   .
  lastcommand := badcommand;   interupt(intproc);
  repeat     {    the    commmand    loop    }
    if timeout   then begin timeoutsave;   command := enditall; end
    else
      begin
        {   prompt   for  user  command   }
        writeln;   writeln(' :');   { putseg(output);  flush buffer }
        getln;
        if eos(input)   then getseg(input);   getch;   getnb;
        {   Another  instance   of  that  I/O  mess.
            Note:  The Pascal programs that are interpreted by
            Pascal-I run interactively (how else) and have
            none of this garbage.
        }
     3: getcommand(command);
     1: case command of
          bottom: botcom;
          change: ccom(false);
          compilecom: compcom;
          continue: execom(true);
          .
          .
          .    {  there are about thirty more commands  }
          .
          question: qmcom;
        end;
      end;
      .
      .   {  command loop wrap-up stuff here   }
      .
    aborted := false;   abtcnt := 0;
  until command in [bye, enditall];
13:  {  terminate program on multiple aborts and fatal errors  };
  if abend <> notfatal then printfatal(abend);
  message('- End Pascal-I');
end {  Pascal-I  }.
```

The entire supplemental system routines are presented here. Bill Cheswick coded these for CDC's NOS operating system.

```
          ident  pi-aid
          syscom b1
          title  pi-aid - Pascal-I helper routines.
          space  4,10


***       rename - change local file name.
*
*         rename(ifet, name)

          entry  rename
 rename   ps
          bx6    x1           new file name
          sa6    x0+13+1      efet + 1
          eq     rename       exit


 interup  space  4,10
***       interup - set user-abort interupt address.
*
*         interup(procaddr)

          entry  interup
 interup  ps
          sx6    x0           get proc address
          sa6    inta
          distc  on,int1,int
          eq     interup      exit

*         entry on user abort.

 int1     bss    20B
          sb1    1
          sa1    inta         get procedure address
          sb7    x1
          zr     x7,*+400000B  if no address to jump to
          sx6    b1           reason code = user abort
          jp     b7           exit to processor

 inta     data   0            address of interupt procedure
```

```
          space  4,10
***       rtime - get realtime since deadstart.
*
*         x := rtime
*
*         returns the time since deadstart as a real number, accurate
*         to milliseconds.

          entry  rtime
 rtime    ps
          rtime  rtia
          sa1    rtia
          mx0    -36
          bx6    -x0*x1       millisecs
          px6
          nx6
          sa1    =0.001
          fx6    x6*x1
          nx6
          eq     rtime        exit

 rtia     bss    1            rtime status word
          space  4,10
          end
```

Of all the complex functions described, getting the real time took the most code to implement. Implementing Pascal-I on IBM, DEC and other systems proved easy because of the simplicity and isolation of the system dependent interface.

****

```
program LISP(input, output);

{
   The essence of a LISP Interpreter.
   Written by W. Taylor and L. Cox
   First date started : 10/29/76
   Last date modified : 12/10/76
  }

label
  1, {   used to recover after an error by the user   }
  2 {   in case the end the file is reached before a fin card   };

const
  maxnode = 600;

type
  inputsymbol =
    (atom, period, lparen, rparen);
  reservedwords =
    (replacehsym, replacetsym, headsym, tailsym, eqsym, quotesym,
     atomsym, condsym, labelsym, lambdasym, copysym, appendsym, concsym,
     conssym);
  statustype =
    (unmarked, left, right, marked);
  symbexpptr = ^symbolicexpression;
  alfa = array [1 .. 10] of char;
  symbolicexpression = record
                         status: statustype;
                         next: symbexpptr;
                         case anatom: boolean of
                           true: (name: alfa;
                                  case isareservedword: boolean of
                                    true: (ressym: reservedwords));
                           false: (head, tail: symbexpptr)
                       end;
{
   Symbolicexpression is the record structure used
   to implement a LISP list.  This record has a tag
   field 'anatom' which tells which kind of node
   a particular node represents (i.e. an atom or
   a pair of pointers 'head' and 'tail').
   'Anatom' is always checked before accessing
   either the name field or the head and tail
   fields of a node.  Two pages ahead there are
   three diagrams which should clarify the data
   structure.
  }


{             T h e   g l o b a l   v a r i a b l e s                }

var

{   Variables which pass information from the scanner to the read
         routine    }
  lookaheadsym, {    used to save a symbol when we back up    }
  sym: inputsymbol {    the symbol that was last scanned         };
  id: alfa {    name of the atom that was last read        };
  alreadypeeked: boolean {    tells 'nextsym' whether we have peeked    };
  ch: char {    the last character read from input        };
  ptr: symbexpptr {    the pointer to the expression being evaluated    };

          {   the global lists of LISP nodes    }

  freelist, {    pointer to the linear list of free nodes    }
  nodelist, {    pointer used to make a linear scan of all
            the nodes during garbage collection          }
  alist: symbexpptr;

  {   two nodes which have constant values    }
  nilnode, tnode: symbolicexpression;

  {   variables used to identify atoms with pre-defined meanings    }
  resword: reservedwords;
  reserved: boolean;
  reswords: array [reservedwords] of alfa;
  freenodes: integer {    number of currently free nodes known    };
  numberofgcs: integer {    number of garbage collections made     };

{                                                                   }
{                                                                   }
{                                                                   }
{                                         \                         }
{                                          \                        }
{                                           \                       }
{       the atom 'a' is                  ----\----                  }
{       represented by --->              i       i                  }
{                                        i   a   i                  }
{                                        i       i                  }
{                                        ---------                  }
{                                                                   }
{                                                                   }
{                                                                   }
{                                                                   }
{                                    \                              }
{                                     \                             }
{                                      \                            }
{                                -------\-------                    }
{        the dotted pair         i      i      i                    }
{        '( a . b )' is          i   /  i  \   i                    }
{        represented by --->     i  /   i   \  i                    }
{                                --/---------\--                    }
{                                 /           \                     }
{                            ----/----     ----\----                }
{                            i       i     i       i                }
{                            i   a   i     i   b   i                }
{                            i       i     i       i                }
{                            ---------     ---------                }
{                                                                   }
{                                                                   }
{                                       \                           }
{                                        \                          }
{                                         \                         }
{                                    -------\-------                }
{                                    i      i      i                }
{        the list '( a b )'          i   /  i  \   i                }
{        is represented              i  /   i   \  i                }
{        by --->                     --/---------\--                }
{                                     /           \                 }
{                                ----/----         \                }
{                                i       i          \               }
{                                i   a   i    -------\-------       }
{                                i       i    i      i      i       }
{                                ---------    i   /  i  \   i       }
{                                             i  /   i   \  i       }
{                                             --/---------\--       }
{                                              /           \        }
{                                         ----/----     ----\----   }
{                                         i       i     i       i   }
{                                         i   b   i     i  nil  i   }
{                                         i       i     i       i   }
{                                         ---------     ---------   }
{                                                                   }
{                                                                   }

{                 t h e   g a r b a g e   c o l l e c t o r         }


procedure garbageman;
{
  In general there are two approaches to maintaining lists of
  available space in list processing systems...  The reference
  counter technique and the  garbage collector  technique.

  The reference counter technique requires that for each node
  or record we maintain a count of the number of nodes which
  reference or point to it, and update this count continuously.
  (i.e. with every manipulation.)  In general, if circular or ring
  structures are permitted to develop this technique will not be
  able to reclaim rings which are no longer in use and have been
  isolated from the active structure.

  The alternative method, garbage collection, does not function
  continuously, but is activated only when further storage is
  required and none is available.  The complete process consists
  of two stages.  A  marking  stage which identifies nodes still
  reachable (in use) and a  collection  stage where all nodes in
  the system are examined and those not in use are merged into
  a list of available space.  This is the technique we have chosen
  to implement here for reasons of simplicity and to enhance the
  interactive nature of our system.

  The marking stage is theoretically simple, especially in LISP
  programming systems where all records are essentially the same
  size.  All that is required is a traversal of the active list
  structures.  The most obvious marking system consists of a procedure
  which makes a number of successive passes through the data
  structure, each time marking nodes 1 level deeper into the tree
  on each pass.  This is both crude and inefficient.

  Another alternative procedure which could be used would use a
  recursive walk of the tree structure to mark the nodes in use.
  This requires the use of a stack to store back pointers to
  branches not taken.  This algorithm is efficient, but tends to
  be self defeating in the following manner.  The requisite stack could
  become quite large (requiring significant amounts of storage).
  However, the reason we are performing garbage collection in the
  first place is due to an insufficiency of storage space.  Therefore
  an undesirable situation is likely to arise where the garbage
  collector's stack cannot expand to perform the marking pass.
  Even though there are significant amounts of free space waiting
  to be reclaimed.

  A solution to this dilemma came when it was realized that space
  in the nodes themselves (i.e. the left and right pointers) could
  be used in lieu of the explicit stack.  In this way the stack
  information can be embedded into the list itself as it is traversed.
  This algorithm has been discussed in Knuth and in Berztiss: Data
  Structures, Theory and Practice (2nd ed.), and is implemented below.

  Since Pascal does not allow structures to be addressed both with
  pointers and as indexed arrays, an additional field has been added
  to sequentially link the nodes.  This pointer field is set on initial
  creation, and remains invarient throughout the run.  Using this field,
  we can simulate a linear pass through the nodes for the collection
  stage.  Of course, a marker field is also required.
  }


  procedure mark(list: symbexpptr);

    var
      father, son, current: symbexpptr;

    begin
      father := nil;   current := list;   son := current;
      while current <> nil do
        with current^ do
          case status of
            unmarked:
              if anatom   then status := marked
              else
                if (head^.status <> unmarked) or (head = current)
                then
                  if (tail^.status <> unmarked) or (tail = current)
                  then status := marked
                  else
                    begin
                      status := right;   son := tail;   tail := father;
                      father := current;   current := son
                    end
                else
                  begin
                    status := left;   son := head;   head := father;
                    father := current;   current := son
                  end;
            left:
              if tail^.status <> unmarked
              then
                begin
                  status := marked;   father := head;   head := son;
                  son := current
                end
              else
                begin
                  status := right;   current := tail;   tail := head;
                  head := son;   son := current
                end;
            right:
              begin
                status := marked;   father := tail;   tail := son;
                son := current
              end;
            marked: current := father
          end {   case   }
    end {  mark  };


  procedure collectfreenodes;

    var
      temp: symbexpptr;

    begin
      writeln(' number of free nodes before collection = ', freenodes: 1
      , '.');
      freelist := nil;   freenodes := 0;   temp := nodelist;
      while temp <> nil do
        begin
          if temp^.status <> unmarked   then temp^.status := unmarked
          else
            begin
              freenodes := freenodes + 1;   temp^.head := freelist;
              freelist := temp
            end;
          temp := temp^.next
        end;
      writeln(' number of free nodes after collection = ', freenodes: 1,
         '.');
    end {  collectfreenodes  };


  begin {   garbageman   }
    numberofgcs := numberofgcs + 1;   writeln;
    writeln(' garbage collection. ');   writeln;   mark(alist);
    if ptr <> nil   then mark(ptr);   collectfreenodes
  end {  garbageman  };


procedure pop(var sptr: symbexpptr);

  begin
    if freelist = nil then
      begin
        writeln(' not enough space to evaluate the expression.');
      {  goto 2  }
      end;
    freenodes := freenodes - 1;   sptr := freelist;
    freelist := freelist^.head
  end {  pop  };


{       i n p u t / o u t p u t   u t i l i t y   r o u t i n e s    }


procedure error(number: integer);

  begin
    writeln;   write('  Error   ', number: 1, ',');
    case number of
      1: writeln(' atom or lparen expected in the s-expr. ');
      2: writeln(' atom, lparen, or rparen expected in the s-expr. ');
      3: writeln(' label and lambda are not names of functions. ');
      4: writeln(' rparen expected in the s-expr. ');
      5: writeln(' 1st argument of replaceh is an atom. ');
      6: writeln(' 1st argument of replacet is an atom. ');
      7: writeln(' argument of head is an atom. ');
      8: writeln(' argument of tail is an atom. ');
      9: writeln(' 1st argument of append is not a list. ');
      10: writeln(' comma or rparen expected in concatenate. ');
      11: writeln(' end of file encountered before a "fin" card. ');
      12: writeln(' lambda or label expected.  ')
    end {  case  };
        if number in [11] then goto 2
                          else goto 1
  end {  error  };

{
    Procedure backupinput puts a left parenthesis
    into the stream of input symbols.  This makes
    procedure readexpr easier than it otherwise
    would be.
  }


procedure backupinput;

  begin alreadypeeked := true;   lookaheadsym := sym;   sym := lparen
  end {   backupinput   };
```

```


    Procedure nextsym reads the next symbol from
    the input file.  A symbol is defined by the
    global type 'inputsymbol'.     The global variable
    'sym' returns the type of the next symbol read.
    The global variable 'id' returns the name of an
    atom if the symbol is an atom.  If the symbol is
    a reserved word the global variable 'reserved'
    is set to true and the global variable 'resword'
    tells which reserved word was read.


procedure nextsym;

  var
    i: integer;

  begin
    if alreadypeeked
    then begin sym := lookaheadsym;   alreadypeeked := false end
    else
      begin
        while ch = ' ' do
          begin if eoln(input)   then writeln;   read(ch);   write(ch);
          end;
        if ch in ['(', '.', ')']
        then
          begin
            case ch of
              '(': sym := lparen;
              '.': sym := period;
              ')': sym := rparen
            end {  case  };
            if eoln(input)   then writeln;   read(ch);   write(ch)
          end
        else
          begin
            sym := atom;   id := '          ';   i := 0;
            repeat
              i := i + 1;   if i < 11   then id[i] := ch;
              if eoln(input)   then writeln;   read(ch);   write(ch)
            until ch in [' ', '(', '.', ')'];
            resword := replacehsym;
            while (id <> reswords[resword]) and (resword <> conssym) do
              resword := succ(resword);
            reserved := id = reswords[resword]
          end
      end
  end {   nextsym   };


procedure readexpr(var sptr: symbexpptr);
{
    This procedure recursively reads in the next symbolic expression
    from the input file.  When this procedure is called the global
    variable 'sym' must be the first symbol in the symbolic expression
    to be read. A pointer to the symbolic expression read is returned
    via the variable parameter sptr.
    Expressions are read and stored in the appropriate structure
    using the following grammar for symbolic expressions :

         <s-expr> ::= <atom>
                  or ( <s-expr> . <s-expr> )
                  or ( <s-expr> <s-expr> ... <s-expr> )

    Where ... means an arbitrary number of. (i.e. zero or more.)
    To parse using the third rule, the identity
         (a b c ... z) = (a . (b c ... z))
    is utilized.  An extra left parenthesis is inserted into
    the input stream as if it occured after the imaginary dot.
    When it comes time to read the imaginary matching
    right parenthesis it is just not read (because it is not there).
  }

  var
    nxt: symbexpptr;

  begin
    pop(sptr);   nxt := sptr^.next;
    case sym of
      rparen, period: error(1);
      atom:
        with sptr^ do
          begin {   <atom>   }
            anatom := true;   name := id;   isareservedword := reserved;
            if reserved   then ressym := resword
          end;
      lparen:
        with sptr^ do
          begin
            nextsym;
            if sym = period   then error(2)
            else
              if sym = rparen   then sptr^ := nilnode {   () = nil   }
              else
                begin
                  anatom := false;   readexpr(head);   nextsym;
                  if sym = period
                  then
                    begin {     <<s-expr> . <s-expr>)      }
                      nextsym;   readexpr(tail);   nextsym;
                      if sym <> rparen   then error(4)
                    end
                  else
                    begin {     ( <s-expr> <s-expr> ... <s-expr> )      }
                      backupinput;   readexpr(tail)
                    end
                end
          end {   with   }
    end {  case  };
    sptr^.next := nxt
  end {   readexpr   };


procedure printname(name: alfa);
{
    Procedure printname prints the name of
    an atom with one trailing blank.
  }

  var
    i: integer;

  begin
    i := 1;
    repeat write(name[i]);   i := i + 1
    until (name[i] = ' ') or (i = 11);
    write(' ')
  end {   printname   };


procedure printexpr(sptr: symbexpptr);
{
    The algorithm for this procedure was provided by
    Weissman's LISP 1.5 Primer, p.125.  This
    procedure prints the symbolic expression pointed
    to by the argument 'sptr' in the lisp list
    notation.  (The same notation in which expressions
    are read.)
  }

  label
    1;

  begin
    if sptr^.anatom   then printname(sptr^.name)
    else
      begin
        write('(');
     1: with sptr^ do
          begin
            printexpr(head);
            if tail^.anatom and (tail^.name = 'NIL       ')
            then write(')')
            else
              if tail^.anatom
              then
                begin write('.');   printexpr(tail);   write(')') end
              else begin sptr := tail;   goto 1 end
          end
      end
  end {   printexpr   };

{         end of i/o utility routines       }


{         The Expression Evaluater Eval   }

function eval(e, alist: symbexpptr): symbexpptr;
{
    Function eval evaluates the LISP expression 'e' using the
    association list 'alist'.  This function uses the following
    several local functions to do so.  The algorithm is a
    Pascal version of the classical LISP problem of writing
    the LISP eval routine in pure LISP.  The LISP version of
    the code is as follows:

    (lambda (e alist)
      cond
        ((atom e) (lookup e alist))
        ((atom (car e))
          (cond ((eq (car e) (quote quote))
              (cadr e))
            ((eq (car e) (quote atom))
              (atom (eval (cadr e) alist))
            ((eq (car e) (quote eq))
              (eq (eval (cadr e) alist)))
            ((eq (car e) (quote car))
              (car (eval (cadr e) alist)))
            ((eq (car e) (quote cdr))
              (cdr (eval (cadr e) alist)))
            ((eq (car e) (quote cons)
              (cons (eval (cadr e) alist)
                (eval (caddr e) alist)
            ((eq (car e) (quote cond)
              (evcon (cdr e))
            (t (eval (cons (lookup (car e) alist)
              (cdr e)) alist)))
          ((eq (caar e) (quote label))
            (eval (cons (caddar e)
              (cdr e)
            (cons (cons (cadar e) (car e))
              alist) ))
        ((eq (caar e) (quote lambda))
          (eval (caddar e)
            (bindargs (cadar e) (cdr e) )))))

    The resulting Pascal code follows:
  }

  var
    temp, carofe, caarofe: symbexpptr;
{
     The first ten of the following local functions implement
     ten of the primitives which operate on the LISP data
     structure.  The last three local functions, 'lookup',
     'bindargs' and 'evcon', are used by 'eval' to interpret
     a LISP expression.
    }


  function replaceh(sptr1, sptr2: symbexpptr): symbexpptr;

    begin
      if sptr1^.anatom   then error(5)   else sptr1^.head := sptr2;
      replaceh := sptr1
    end {   replaceh   };


  function replacet(sptr1, sptr2: symbexpptr): symbexpptr;

    begin
      if sptr1^.anatom   then error(6)   else sptr1^.tail := sptr2;
      replacet := sptr1
    end {   replacet   };


  function head(sptr: symbexpptr): symbexpptr;

    begin if sptr^.anatom   then error(7)   else head := sptr^.head
    end {   head   };


  function tail(sptr: symbexpptr): symbexpptr;

    begin if sptr^.anatom   then error(8)   else tail := sptr^.tail
    end {   tail   };


  function cons(sptr1, sptr2: symbexpptr): symbexpptr;

    var
      temp: symbexpptr;

    begin
      pop(temp);   temp^.anatom := false;   temp^.head := sptr1;
      temp^.tail := sptr2;   cons := temp
    end {   cons   };


  function copy(sptr: symbexpptr): symbexpptr;
{
    This function creates a copy of the structure
    pointed to by the parameter 'sptr'
  }

    var
      temp, nxt: symbexpptr;

    begin
      if sptr^.anatom
      then
        begin
          pop(temp);   nxt := temp^.next;   temp^ := sptr^;
          temp^.next := nxt;   copy := temp
        end
      else copy := cons(copy(sptr^.head), copy(sptr^.tail))
    end {   copy   };


  function append(sptr1, sptr2: symbexpptr): symbexpptr;
{
    The recursive algorithm is from Weissman, p.97.
  }

    begin
      if sptr1^.anatom
      then
        if sptr1^.name <> 'NIL          then error(9)
        else append := sptr2
      else
        append := cons(copy(sptr1^.head), append(sptr1^.tail, sptr2))
    end {   append   };


  function conc(sptr1: symbexpptr): symbexpptr;

{    This function serves as the basic concatenation mechanism
    for variable numbers of list expressions in the input stream.
    The concatenation is handled recursively, using the identity:
      conc(a,b,c,d) = cons(a,cons(b,cons(c,cons(d,nil))))

    The routine is called when a  conc(.... command has been
    recognized on input, and its single argument is the first
    expression in the chain.  It has the side effect of reading
    all following input up to the parenthesis closing the
    conc command.

    The procedure consists of the following steps-
      1. call with 1st expression as argument.
      2. read the next expression.
      3. if the expression just read was not the last, recurse.
      4. otherwise... unwind.
  }

    var
      sptr2, nilptr: symbexpptr;

    begin
      if sym <> rparen
      then
        begin
          nextsym;   readexpr(sptr2);   nextsym;
          conc := cons(sptr1, conc(sptr2));
        end
      else
        if sym = rparen
        then
          begin
            new(nilptr);
            with nilptr^ do
              begin anatom := true;   name := 'NIL       ' end;
            conc := cons(sptr1, nilptr);
          end
        else error(10)
    end {  conc  };


  function eqq(sptr1, sptr2: symbexpptr): symbexpptr;

    var
      temp, nxt: symbexpptr;

    begin
      pop(temp);   nxt := temp^.next;
      if sptr1^.anatom and sptr2^.anatom
      then
        if sptr1^.name = sptr2^.name   then temp^ := tnode
        else temp^ := nilnode
      else
        if sptr1 = sptr2   then temp^ := tnode
        else temp^ := nilnode;
      temp^.next := nxt;   eqq := temp
    end {   eqq   };


  function atom(sptr: symbexpptr): symbexpptr;

    var
      temp, nxt: symbexpptr;

    begin
      pop(temp);   nxt := temp^.next;
      if sptr^.anatom   then temp^ := tnode   else temp^ := nilnode;
      temp^.next := nxt;   atom := temp
    end {   atom   };


  function lookup(key, alist: symbexpptr): symbexpptr;

    var
      temp: symbexpptr;

    begin
      temp := eqq(head(head(alist)), key);
      if temp^.name = 'T         '   then lookup := tail(head(alist))
      else lookup := lookup(key, tail(alist))
    end {   lookup   };


  function bindargs(names, values: symbexpptr): symbexpptr;

    var
      temp, temp2: symbexpptr;

    begin
      if names^.anatom and (names^.name = 'NIL       ')
      then bindargs := alist
      else
        begin
          temp := cons(head(names), eval(head(values), alist));
          temp2 := bindargs(tail(names), tail(values));
          bindargs := cons(temp, temp2)
        end
    end {   bindargs   };


  function evcon(condpairs: symbexpptr): symbexpptr;

    var
      temp: symbexpptr;

    begin
      temp := eval(head(head(condpairs)), alist);
      if temp^.anatom and (temp^.name = 'NIL       ')
      then evcon := evcon(tail(condpairs))
      else evcon := eval(head(tail(head(condpairs))), alist)
    end {   evcon   };


  begin {   e v a l   }
    if e^.anatom   then eval := lookup(e, alist)
    else
      begin
        carofe := head(e);
        if carofe^.anatom
        then
          if not carofe^.isareservedword
          then
            eval := eval(cons(lookup(carofe, alist), tail(e)), alist)
          else
            case carofe^.ressym of
              labelsym, lambdasym: error(3);
              quotesym: eval := head(tail(e));
              atomsym: eval := atom(eval(head(tail(e)), alist));
              eqsym:
                eval := eqq(eval(head(tail(e)), alist), eval(head(tail(
                   tail(e))), alist));
              headsym: eval := head(eval(head(tail(e)), alist));
              tailsym: eval := tail(eval(head(tail(e)), alist));
              conssym:
                eval := cons(eval(head(tail(e)), alist), eval(head(tail(
                   tail(e))), alist));
              condsym: eval := evcon(tail(e));
              concsym:;
              appendsym:
                eval := append(eval(head(tail(e)), alist), eval(head(
                   tail(tail(e))), alist));
              replacehsym:
                eval := replaceh(eval(head(tail(e)), alist), eval(head(
                   tail(tail(e))), alist));
              replacetsym:
                eval := replacet(eval(head(tail(e)), alist), eval(head(
                   tail(tail(e))), alist))
            end {   case   }
        else
          begin
            caarofe := head(carofe);
            if caarofe^.anatom and caarofe^.isareservedword
            then
              if not (caarofe^.ressym in [labelsym, lambdasym])
              then error(12)
              else
                case caarofe^.ressym of
                  labelsym:
                    begin
                      temp := cons(cons(head(tail(carofe)), head(tail(
                         tail(carofe)))), alist);
                      eval := eval(cons(head(tail(tail(carofe))), tail(e
                         )), temp)
                    end;
                  lambdasym:
                    begin
                      temp := bindargs(head(tail(carofe)), tail(e));
                      eval := eval(head(tail(tail(carofe))), temp)
                    end
                end {   case   }
            else
              eval := eval(cons(eval(carofe, alist), tail(e)), alist)
          end
      end
  end {   e v a l   };


procedure initialize;

  var
    i: integer;
    temp, nxt: symbexpptr;

  begin
    alreadypeeked := false;   read(ch);   write(ch);   numberofgcs := 0;
    freenodes := maxnode;
    with nilnode do
      begin
        anatom := true;   next := nil;   name := 'NIL       ';
        status := unmarked;   isareservedword := false
      end;
    with tnode do
      begin
        anatom := true;   next := nil;   name := 'T         ';
        status := unmarked;   isareservedword := false
      end;

  {  - - - -   allocate storage and mark it free   }
    freelist := nil;
    for i := 1 to maxnode do
      begin
        new(nodelist);   nodelist^.next := freelist;
        nodelist^.head := freelist;   nodelist^.status := unmarked;
        freelist := nodelist
      end;

  {  - - - -   initialize reserved word table   }
    reswords[replacehsym] := 'REPLACEH  ';
    reswords[replacetsym] := 'REPLACET  ';
    reswords[headsym] := 'CAR       ';
    reswords[tailsym] := 'CDR       ';
    reswords[copysym] := 'COPY      ';
    reswords[appendsym] := 'APPEND    ';
    reswords[concsym] := 'CONC      ';
    reswords[conssym] := 'CONS      ';
    reswords[eqsym] := 'EQ        ';
    reswords[quotesym] := 'QUOTE     ';
    reswords[atomsym] := 'ATOM      ';
    reswords[condsym] := 'COND      ';
    reswords[labelsym] := 'LABEL     ';
    reswords[lambdasym] := 'LAMBDA    ';

  {  - - - -   initialize the a-list with  t  and  nil    }
    pop(alist);   alist^.anatom := false;   alist^.status := unmarked;
    pop(alist^.tail);   nxt := alist^.tail^.next;
    alist^.tail^ := nilnode;   alist^.tail^.next := nxt;
    pop(alist^.head);

  {  - - - -   bind  nil  to the atom nil    }
    with alist^.head^ do
      begin
        anatom := false;   status := unmarked;   pop(head);
        nxt := head^.next;   head^ := nilnode;   head^.next := nxt;
        pop(tail);   nxt := tail^.next;   tail^ := nilnode;
        tail^.next := nxt
      end;
    pop(temp);   temp^.anatom := false;   temp^.status := unmarked;
    temp^.tail := alist;   alist := temp;   pop(alist^.head);

  {  - - - -   bind  t  to the atom  t    }
    with alist^.head^ do
      begin
        anatom := false;   status := unmarked;   pop(head);
        nxt := head^.next;   head^ := tnode;   head^.next := nxt;
        pop(tail);   nxt := tail^.next;   tail^ := tnode;
        tail^.next := nxt
      end;
  end {   initialize   };
```

```
begin {  LISP  }
  writeln(' * EVAL * ');   initialize;   nextsym;   readexpr(ptr);
  readln;  writeln;
  while not ptr^.anatom or (ptr^.name <> 'FIN       ') do
    begin
      writeln;   writeln(' * value * ');   printexpr(eval(ptr, alist));
   1: writeln;   writeln;   if eof(input)   then error(11);
      ptr := nil;
      {   call the   }   garbageman;   writeln;   writeln;
      writeln(' * EVAL * ');   nextsym;   readexpr(ptr);   readln;
      writeln;
    end;
2: writeln;   writeln;
  writeln(' total number of garbage collections = ', numberofgcs: 1, '.'
    );
  writeln;
  writeln(' free nodes left upon exit = ', freenodes: 1, '.');
  writeln;
end {  LISP  }.
```

Articles

An Implementation of New and Dispose using Boundary Tags

Branko J. Gerovac

The standard Pascal procedures New and Dispose are implemented using boundary-tag memory management. This implementation replaces the original New and Dispose module in the run-time library of Oregon Minicomputer Software, Inc. Pascal-1 which executes on Digital Equipment Corp. PDP-11 computers. Design details, although aimed at this configuration, should be generally useful. Performance of the original and boundary-tag implementations are analyzed and compared.

Key words: Pascal, New and Dispose, memory management, boundary tag.

1. Introduction

Many Pascal systems do not fully implement New and Dispose. One can speculate that (1) the full generality of New and Dispose was deemed unnecessary or undesirable, or that (2) efficient algorithms for New and Dispose are not readily available. This paper addresses the latter issue.

The standard Pascal run-time environment has two functionally different data storage areas: the stack and the heap.

The number of accessible data items on the stack is designated by the declarations of a program, and all operations that allocate and release stack storage and access stack data are implicit in program syntax. In addition, the block structure of a program designates the period (lifetime) during which stack storage is set aside.

In contrast, the number and lifetime of items on the heap are largely independent of program declarations, and heap operations are programmed explicitly. At run time, a program must (1) maintain access to heap data, by using pointers, and (2) allocate and release heap storage, by using New and Dispose.

Some Pascal systems implement the heap as a second stack (e.g., P-code Pascal [NAJNJ76]). A second stack requires that a program maintain the information necessary to release heap storage, and that heap storage is released in the reverse order from which it was allocated. This restriction may prevent the programmer from implementing algorithms that use a non-stack-like data structure [cf., HS76, HS78, W76].

Here, a boundary-tag scheme for managing free blocks permits an efficient implementation of New and Dispose. This module has many advantages over the original New and Dispose module in the run-time library of OMSI-Pascal-1 [1]. OMSI-Pascal's original New and Dispose provided some insight into the problems of heap management. With the original module, examples of wide variation in memory efficiency and execution time are apparent. Since one of OMSI-Pascal's strong features is its applicability to real-time programming, many design decisions for the boundary-tag module were aimed at decreasing execution time. Memory efficiency improved also.

Performance analyses of each New and Dispose module are compared. Analyses of specific heap operations were carried out by calculating run times of each implementation. Simulation tests were run to obtain comparative performance during actual execution.

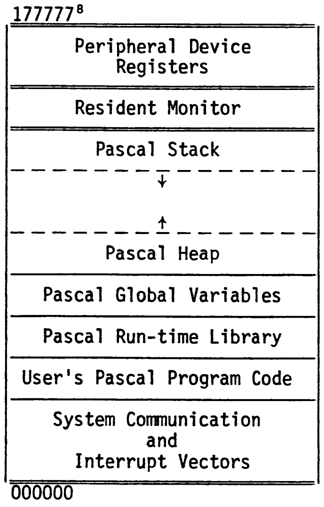
Although a specific hardware-software environment is discussed here, the design rationale would be appropriate for other systems. Pascal sources for each implementation of New and Dispose and assembly language sources for the boundary-tag module are provided to promote general use.

2. Description of the Original New and Dispose Module

The run-time memory configuration of OMSI-Pascal-1 [ESI77], under DEC's RT-11 real-time operating system, is typical for block structured languages [NAJNJ76, AU77]. The operating system maintains areas of memory for interrupt vectors, system communication, the resident monitor and peripheral device registers [DEC78]. When a Pascal program is run, the program code is loaded into low memory, and then a Pascal run-time library routine initializes the data areas. The heap is located in low memory just above the program code and global storage, and the stack is located in high memory. The heap grows upward and the stack grows downward; the unused memory between the heap and the stack is available for expansion of either. No automatic memory-disk swapping of data occurs.

Two pointers are maintained by New and Dispose to manage heap memory: (1) $KORE points to the beginning of the unused area above the heap, and (2) $FREE points to a list of free blocks in the heap. The free list is a singly linked list of blocks that have been disposed [2]. Each free block contains (1) a pointer to the next block in the list (a nil pointer if it is the last block in the list) and (2) the block's size. An advantage of the free list is that the information needed to manage a free block is contained within the block, thus no additional memory overhead is required for free-block management. (Computers with virtual memory may benefit from a separate table of free blocks to avoid excessive memory-disk swapping.)

Diagram of Memory Layout:



New. To allocate storage on the heap, program code passes the size needed to New [3]. (Appendix A contains Pascal sources of New and Dispose.) If one word is requested, it is allocated by extending the top of the heap by one word; one-word blocks do not fit on the free list because two words are necessary to contain pointer and size information. For a request of more than one word, the free list is searched for a block of the exact size (exact-fit) of the block requested. If such a block is found, it is unlinked from the list and allocated; if no such block is found or the free list is empty, the heap is extended by the number of words needed to allocate the block. If collision with the stack results from extending the heap, program execution is terminated. The newly allocated block is zeroed to provide a clean slate and to help prevent inadvertant violation of the free list. New returns the address of the new block, and program code assigns this address to a pointer.

Dispose. To release storage to the heap, program code passes the address and the size of the block to Dispose. A block that is larger than one word is linked to the

Author's address: Behavioral Sciences Department, Eunice Kennedy Shriver Center for Mental Retardation, 200 Trapelo Road, Waltham, Massachusetts 02154; Phone: (617)893-3500.

[1] Oregon Minicomputer Software, Inc. distributes and maintains the Pascal system that was implemented by Electro Scientific Industries. An earlier version of OMSI-Pascal-1 was known as ESI-Pascal. This Pascal was one of the first to implement Dispose. OMSI-Pascal runs on Digital Equipment Corp. PDP-11 computers and uses standard operating system facilities.

[2] Since New and Dispose may be called in any sequence, the heap can contain a mix of allocated and free blocks. The free list permits New to reuse free blocks.

[3] The size is always an even number of bytes due to the PDP-11's restriction that word based data, e.g., integers, be stored at even byte (word) locations.

beginning of the free list and its size is recorded; a one-word block effectively is not released. Then, the free list is searched for a block adjacent to the top of the heap. If a block is found, it is released from the heap by unlinking it from the free list and decrementing $KORE. This search is repeated until a full scan of the list is made without a decrease in the upper bound of the heap.

The original implementation of New and Dispose is uncomplicated, requires little code, and seems as though it would work well with typical Pascal programs. Generally, only a few different data sizes are specified in a program. The exact-fit allocation scheme often finds the size block needed in the free list; the size of the last disposed block is likely to be the same as the size of the next requested block, hence, placement of the disposed block at the beginning of the free list may speed allocation. However, problems arise when worst-case memory-space and execution-time performance are considered.

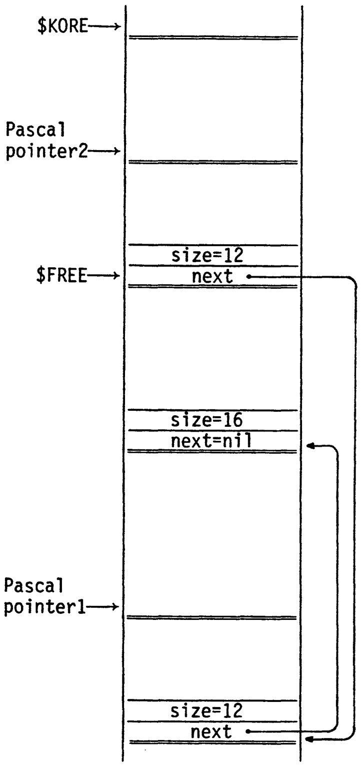
For example, since the free list does not keep track of disposed one-word blocks, one-word blocks limit the extent to which the upper bound of the heap can be reduced. Free blocks that are below a one-word block will never be adjacent to the top of the heap and cannot be released. Even so, Dispose continues to scan these free blocks. A simple solution would allocate two words for a one-word request so that the block would fit on the free list.

Another problem, easily fixed, is the unnecessary search that Dispose makes when a block is first linked to the free list. The free list need be searched only if the block currently being disposed is adjacent to the top of the heap.

Even with these changes, certain configurations of the free list generate inefficient memory use and a wide range of execution times.

Consider a program that places 100 blocks of one size in the free list. Suppose the program then requests a block of some different size. Since New employs an exact-fit algorithm, a search of the free list will not produce a block of the correct size and the heap will be extended for the new block. Effectively, 100 blocks of storage are not usable, the total size of the heap is larger than necessary, and the execution time of New has increased by the amount of time required to search 100 blocks.

Diagram of Heap, original module:



Now consider that the 100 blocks were disposed in the reverse order from which they were allocated (last allocated, first freed). In other words, the blocks nearer the top of the heap are farther from the beginning of the free list. When the final block (keystone) between the top of the heap and the 100 blocks on the free list is disposed, a chain reaction releases all 100 blocks from the heap. However, the full depth of the free list must be scanned for each block to be released. This results in a single call of Dispose that performs 5,050 comparisons, i.e., a complexity of O[Sqr(N)/2].

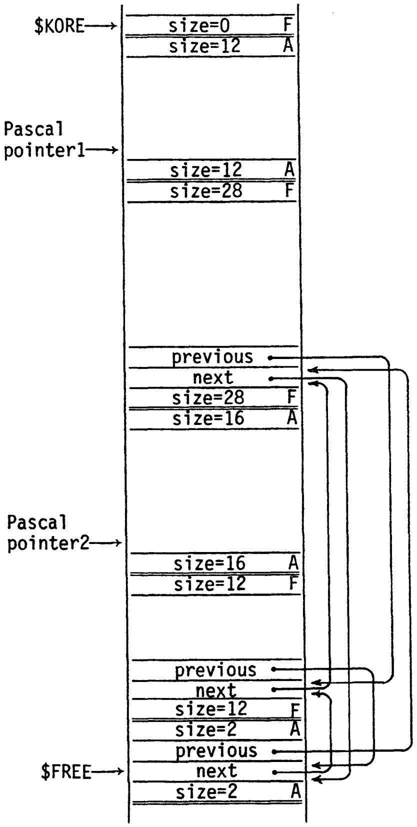
3. Selection and Design of a Heap Management Algorithm

In both cases described above, the large number of free blocks causes worst-case performance. This number can be reduced by merging adjacent free blocks. The resulting larger block would be available for allocation when its constituent blocks would have been too small. By allocating a portion of a large block and returning the remainder to the free list, the larger block is available for a variety of smaller size allocations. Thus, reusability of available memory is enhanced.

Since the heap grows toward the stack, the upper extent of the heap should be kept as low as possible. To accomplish this, blocks in the free list can be ordered by memory location; blocks which are nearer the bottom of the heap are placed closer to the beginning of the list. New, employing a first-fit search algorithm, allocates the lowest free block of sufficient size. If the block exceeds the requested size, only the lower portion is allocated, and the remainder is returned to the free list. Biasing heap allocations toward lower memory helps avoid collision with the stack.

Dispose, then, maintains the ordered free list, and merges adjacent free blocks. Simply, when a block is disposed, a comparison with blocks already in the free list would determine whether to merge the disposed block with a free block or to insert the disposed block into the free list; potentially, a full scan of the free list would be needed. However, literature on memory-allocation strategies [K73, S74, G76, H76, HS76] indicates that a dispose operation can be performed without scanning the free list by employing Knuth´s "Boundary Tag" scheme for free-block management [K73]. The implementation presented here differs from Knuth´s presentation in order to maintain the ordered free list.

Diagram of a Heap, boundary-tag module:



The boundary-tag scheme uses two additional words of storage to mark the boundaries of each block; lower and upper boundary words are identical. Each boundary word contains the size of the block and a one-bit tag that signifies whether the block is allocated or free. Since the size is always an even number of bytes, bit zero can be used to tag the block. Bit zero is clear to indicate that the block is free and is set to indicate that the block is allocated. Dispose need check only the boundary words of the blocks adjacent to the block being disposed to determine whether a merge can be performed.

Each free block contains two pointers which enable access to the next and previous free blocks during insert and merge operations. Placement and referencing of the pointers was chosen to facilitate access using the auto-increment/auto-decrement addressing modes of the PDP-11 instruction set. Also, placement at the bottom of the block corresponds to Pascal pointer referencing. (Although, placement of the pointers at the top of the block would seem advantageous when the lower portion is allocated, preliminary coding indicated a marked increase in code size and a very slight decrease in execution time.)

The heap is initialized with boundary blocks at the bottom and top of the heap. $FREE points to the lower boundary block, which is tagged as being allocated, and links the bottom and top of the free list into a circular list; the list can be traversed in either direction. $KORE points to the upper boundary block, which is tagged as free and has a size of zero. This is a pseudo block in that it is not linked into the free list; it serves only to provide a boundary word to check when the block adjacent to $KORE is being disposed. The boundary blocks eliminate the need for tests which otherwise would have to check boundary conditions during insertion on and removal from the free list. Without boundary blocks, Dispose would have required as many as 8 conditional tests to select from 12 separate operations. With the boundary blocks, only 4 tests and 6 operations are needed.

4. Description of the Boundary-Tag New and Dispose Module

The boundary-tag module was written so that no changes to the compiler or the rest of the run-time library would be needed (see Appendix Notes).

New. To allocate storage on the heap, program code passes the size of the block to New. (Appendix B contains Pascal sources of New and Dispose, and Appendix D, Macro-11 sources.) A request for one word is changed to two words. The free list is searched starting at the bottom. If a large enough block is not found, then the heap is extended, providing that the heap does not collide with the stack. If a block which is larger than needed is found, the lower portion is allocated and the upper portion (remainder) is returned to the free list. However, if the remainder would be too small to fit in the free list, the entire block is allocated. Then, the tags of the new block are set, the block is zeroed, and its address returned.

Dispose. To release storage to the heap, program code passes the address and the size of the block to Dispose; the size parameter is ignored since the actual size of the block is contained in the boundary word. The block's tag is checked to see that it is allocated and the block's address is checked to see that it is within the heap (OMSI-Pascal has been extended to permit pointers to data which are not stored on the heap). Then its tags are set to free, and the addresses of the lower- and upper-adjacent words are calculated. If the lower-adjacent block is free, the two blocks are merged; a merge with a lower-adjacent block is rapid, since the next and previous links are not changed. If the upper-adjacent word is the top of the heap ($KORE) the block is released from the heap. If the upper-adjacent block is free, the blocks are merged and the links are adjusted; link adjustment depends on whether a merge with the lower-adjacent block had occurred. If neither adjacent block is free, the free list is scanned to compare the address of the block being disposed with the addresses of blocks in the free list. The disposed block is inserted in proper order, maintaining the ordered free list.

Problems in the original module have been corrected. One-word requests return a two-word block that will fit in the free list without special handling. Allocations are made from the lowest possible free block; the upper free blocks are more likely to be released from the heap. Free blocks are merged; the larger blocks are available for a variety of allocation sizes, and the shorter free list is more rapidly scanned. Boundary tags permit most blocks to be disposed without a scan through the free list.

5. Static Analysis

The additional operations of the boundary-tag module require more than twice the instruction space of the original. The number of storage words for each procedure is:

	original	boundary tag
New	38	103
Dispose	33	78

Execution-time equations for both New and Dispose modules were calculated using the instruction execution times given by the manufacturer for an LSI-11 with a 350 nanosecond microcycle time [DEC77]. Representative data, based on simulation tests (N=4, random) presented in the next section, are shown in brackets; all execution times are in microseconds (us). Subsequent references to the original implementation of New and Dispose and the boundary-tag implementation of New and Dispose are indicated respectively by New-org, Dispose-org, New-tag and Dispose-tag.

New-org performs three likely forms of allocation: (1) the free list is empty, allocate by extending the heap, (2) a free block of the correct size is found, allocate this block, and (3) the free list contains blocks that are not the correct size, allocate by extending the upper bound of the heap. The execution-time equations for New-org are:

1.	free list empty	89.25 + 28.70*L	[433.65us]
2.	allocate free block	76.30 + 30.80*Korg + 28.70*L	[497.70us]
3.	extend heap	117.95 + 30.80*Norg + 28.70*L	[1232.35us]

Norg [25] the number of blocks on the free list.
Korg [2.5] the number of blocks searched to find one of the correct size.
L [12] the size in words of the newly allocated block, represents the time required to zero the block (the 28.7*L term could be recoded to 11.9*L).

The New-tag algorithm also performs three forms of allocation: (1) allocate an entire block from the free list, (2) allocate the lower portion of a block from the free list, and (3) allocate by extending the heap. New-tag:

1.	entire free block	160.65 + 26.60*Ktag + 11.90*L	[303.45us]
2.	portion of free block	207.90 + 26.60*Ktag + 11.90*L	[350.70us]
3.	extend heap	176.05 + 26.60*Ntag + 11.90*L	[531.65us]

Ntag [8] the number of blocks on the free list.
Ktag [3] the number of blocks searched to find one of the correct size.
L [12] the size in words of the newly allocated block.

The advantage of New-tag results from the fewer blocks contained on its free list. In the 100 free-block example given in section 2, a single call of New-org runs 3,542.35 us., while New-tag runs 378.00 us. The free list for New-tag contains only one block. Remember that New-org is extending the heap, while New-tag is reusing memory from the free list.

The Dispose-org algorithm has two major forms of releasing storage: (1) add the block to the free list and do not decrease the upper bound of the heap, and (2) decrease the upper bound of the heap by the size of the block being disposed. Also, (3) worst-case execution time for a single call is the dispose of the keystone block described in section 2; representative time is given with Norg=25 for comparison with (1) and (2). Dispose-org:

1.	add to free list	72.45 + 42.00*Norg	[1,122.45us]
2.	decrease heap	92.05 + 42.00*Norg	[1,142.05us]
3.	worst-case	72.45 + 42*(Sqr(Norg)/2) + 61.60*Norg	[14,737.45us]

The Dispose-tag algorithm has six forms of releasing storage: (1) scan the free list and insert the block without a merge, and (2) five forms of merging the block without a scan, the range and average of these are given. (3) The keystone dispose is not worst case for Dispose-tag; it would execute as a merge operation. Instead, worst case is a full scan of the free list to insert the block at the bottom of the free list. Dispose-tag:

1.	scan and insert	143.85 + 14.70*(Ntag/2)	[202.65us]
2.	merge	range (134.05 .. 205.10)	[average 173.74us]
3.	worst-case	143.85 + 14.70*Ntag	[261.45us]

An examination of the time needed to dispose an entire list shows the effect that multiple Dispose operations have on program execution. Assume a list of blocks is allocated and numbered in order of allocation (1,2,3..X); the free list is initially empty. Two simple cases of disposing the list are: (1) LAFF—last allocated, first freed—blocks are disposed in the reverse order from which they were allocated (X..3,2,1). Each call of Dispose decreases the upper bound of the heap. And, (2) FAFF—first allocated, first freed—blocks are disposed in the same order as allocation (1,2,3..X). Each call of Dispose adds the block to the free list; the last call decreases the upper bound of the heap by the extent of the entire list. Also, worst case for each version of Dispose is: (3) LAFF-keystone, described in section 2 ((X-1)..3,2,1,X), is worst case for Dispose-org. And, (4) odd-LAFF/even-FAFF is worst case for Dispose-tag. The odd numbered blocks are disposed in reverse order, then all even numbered blocks are disposed in increasing order ((X-1)..5,3,1,2,4,6..X); assume X is an even number. Each dispose of an odd numbered block must scan the entire free list to insert the block in order, the even numbered blocks merge with both lower- and upper-adjacent, and the Xth block decreases the upper bound of the heap by the extent of the list.

Dispose a list with X blocks [X=100]:

		original	boundary tag
1.	LAFF	134.05 * X [13,405us]	134.05 * X [13,405us]
2.	FAFF	(134.05*X)+(42*(Sqr(X)-X)/2) [221,305us]	355.60+(142.80*(X-2)) [14,350us]
3.	LAFF-keystone	(134.05*X)+(42*(Sqr(X)-(X/2))) [431,305us]	134.05 * X [13,405us]
4.	odd-LAFF/even-FAFF	(134.05*X)+ (42*((3/4)*Sqr(X)-X)) [324,205us]	(174.48*X)-(8.05)+ (14.70*((Sqr(X)/8)-(X/4))) [35,447us]

LAFF and LAFF-keystone are respectively the best- and worst-case examples for the original Dispose. The similarity of ordering between the two complicates the evaluation of run time for programs using the original module.

While the original implementation of New and Dispose exhibits a wide range of execution times, the boundary-tag implementation is orderly even in the extreme examples.

6. Dynamic Analysis

Simulation tests were run to collect additional information on the comparative performance of the original and boundary-tag implementations of New and Dispose. The simulation program is similar to the one recommended by Knuth [K73] and is based on Monte Carlo techniques.

The test program runs in simulated time; the major loop of the program defines a simulated-clock tick. Briefly, at each clock tick: (1) All blocks that are at their lifetime limit are disposed. (2) Then, a single block is allocated, its size and lifetime determined by generator functions. The allocated block is placed on a list that is ordered by lifetime limit. (3) Statistics on heap size and utilization and the numbers of allocated and free blocks are recorded. Periodically, statistics and an optional picture of memory are output. The program continues until a simulated-time, a real-time, or a heap-size limit is reached; all tests reported here ran the full simulated-time limit of 25,000 ticks. At the end of the program, summary statistics and a frequency plot of memory use are output.

All tests were run with the same main program; only the generator functions for size and lifetime differed. A variety of generator functions were used. The functions were chosen so that the average allocated-block size was 12 words and so that the average number of allocated blocks was 50. A random number generator (0 .. 0.99999) serves as the basis for size and lifetime selection; the same sequence of random numbers was used for all tests.

Seventeen size functions were used. Each generated an even distribution of N block sizes (N = 1..17) centered around 12 words. These 17 size functions are of the form:

size(N) : Trunc((random*N) + (12-Trunc(N/2)))

The function for N=5 requests allocations of 10, 11, 12, 13, or 14 words with equal probabilty. For N=4, allocations of 10, 11, 12, or 13 are requested; functions for even values of N request blocks whose average size is 11.5 words.

Four lifetime functions were used: (1) Random, evenly distributed from 1 to 100 simulated-clock ticks, (2) Queue, fixed value of 50 ticks, (3) Stack, allocate 100 blocks, one per tick, then dispose all of them in the reverse order from which they were allocated, LAFF, and (4) 80% Stack, lifetimes are 80% stack-like and 20% random. The equations for these functions are (simtime is the value of the simulated clock in ticks):

1.	Random:	Trunc(random*100) +1
2.	Queue:	50
3.	Stack:	100 - (simtime mod 100)
4.	80% Stack:	80 - (simtime mod 80) + Trunc(random*20) [if 0 then 1]

Each size function (17) was paired with each lifetime function (4) to produce a test (1 of 68) performed with each New and Dispose module. (Other tests produced similar results.) Statistics were gathered separately for each test-module combination.

Figure 1 plots the average number of blocks on the free list versus the size function for each test. Data points of the same lifetime function and New and Dispose module are connected Each data point is the sum of the free-block counts from each simulated-clock tick averaged over 25,000 ticks. The free-block counts for the stack-lifetime tests were always zero and are not plotted.

Another way to view the results is to consider the ratio (p) of free blocks to allocated blocks; the average number of allocated blocks is approximately 50 for all tests. In the random-lifetime curves, the boundary-tag module starts with p=5.4% when N=1 and increases to p=20.3% when N=7 where a plateau develops not rising above 24%; results with the original module begin with p=10.7% when N=1, p=72.6% when N=7 and continues to increase until p=130.2% when N=17. The other lifetime functions show an even greater difference between the two modules.

Figure 2 shows the average of total heap size divided by the number of allocated words, a measure of a module's memory-space efficiency. A value of 100% means that all words (average 600) are allocated and that there is no additional overhead; the stack-lifetime tests with the original module show this performance. Even though there are no free blocks, stack-lifetime tests with the boundary-tag module show a 17% overhead due to the two boundary words needed for each block. Since the average allocated block is 12 words, 14 words actually are used; smaller or larger blocks

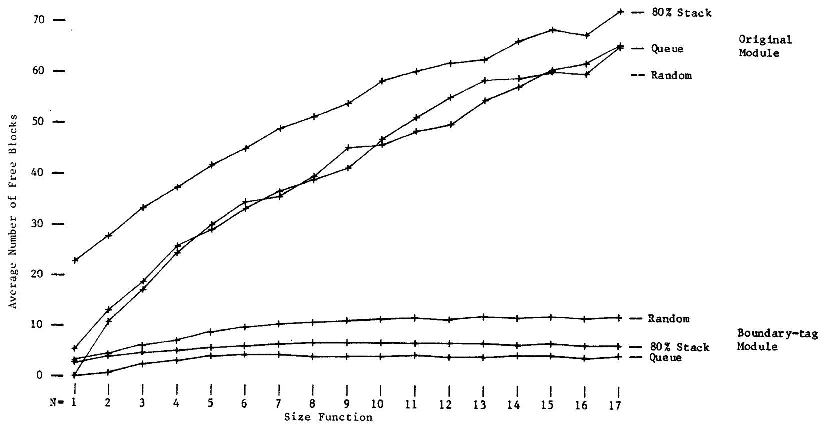


FIGURE 1. FREE BLOCK COUNT

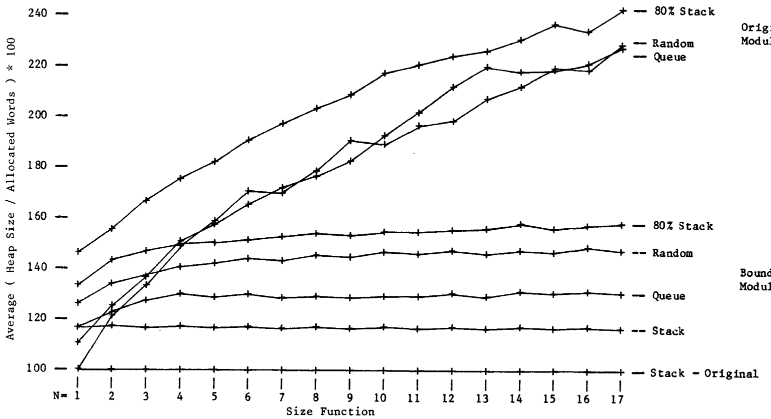


FIGURE 2. HEAP UTILIZATION

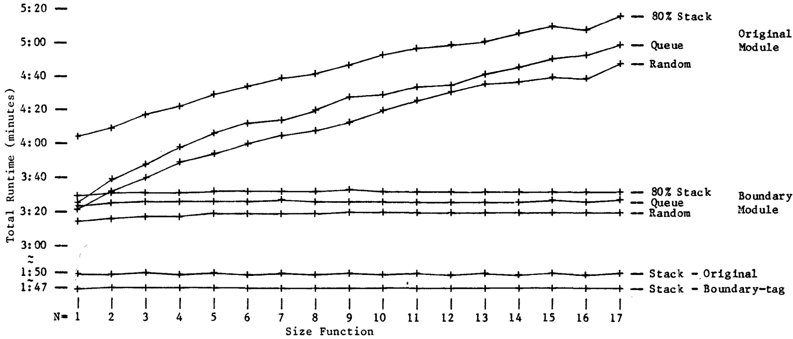


FIGURE 3. TOTAL RUNTIME OF TESTS

respectively raise or lower this overhead. The other lifetime tests show a correspondence between overhead and free blocks. The original module's overhead increases with increasing N while the boundary-tag module's overhead stabilizes.

Maximum heap size also closely corresponds to the number of free blocks and to the average heap size for the various tests. The maximum heap size for the original module was about 17% greater than average heap size, and the maximum for the boundary-tag module was 20% greater. However, maximum heap size for the original module was generally more than 20% greater than maximum heap size for the boundary-tag module.

Figure 3 presents the total run time of each test. Special hardware to measure only the run time of the New and Dispose operations was not available. The simulation program was revised to provide more meaningful run times; specifically, free blocks were not counted and statistics were not gathered since these measures vary between modules. The same random number sequence was used so that these statistical measures would be the same as in the previous tests with the unrevised program. The revised simulation program still included test-specific operations, such as calculation of lifetime and size of the block to be allocated and maintenance of the ordered-by-lifetime list of allocated blocks; however, since the test specific operations depend on the test performed rather than the New and Dispose module, a comparison between modules is meaningful even though comparisons between different test types may not be. Note that the run time difference between the original and boundary-tag modules on the same test is entirely due to the run times of New and Dispose.

The stack-lifetime tests contain the fewest test-specific operations and are considerably shorter than the other tests. The tests with other lifetime functions contain more test-specific operations and exhibit a shape similar to the previous two figures.

The boundary-tag module frequently maintains a smaller heap even though the two additional boundary words are needed per block. Thus, programs using the boundary-tag module are less likely to terminate from heap-stack collision. The boundary-tag module executes faster even though it involves more computation to allocate a portion of a larger block and to doubly link and order the free list.

The boundary-tag module's performance can be explained by the "systematic" memory-management strategy employed. The effects of the ordered free list, the first-fit allocation, and the allocation of the lower portion of a free block ensure that allocations are made as low as possible in memory; this results in a smaller heap and in maximal reuse of free memory. The boundary tags permit a merge of adjacent free blocks without a scan of the free list, and the resulting shorter free list permits a faster scan, when necessary. Similar results are analyzed more fully by Shore [S77].

7. Future Directions

Fine Tuning

The boundary-tag New and Dispose module shows improved performance in execution time and free block count. However, the two boundary words per block sometimes can use a significant proportion of total memory. This is true only when the heap contains many small blocks. Can this overhead be reduced?

The current module optimizes execution time with the added boundary words; however, much of the boundary-tag module's improved performance can be attributed to merged adjacent free blocks, the ordered free list and first-fit allocation. It may be possible to modify or eliminate the boundary words with only a slight increase in execution time.

To permit separate tests of each modification, the module should be revised in stages that progressively simplify the structure of a heap block. First, remove the upper boundary word. Without this boundary tag, the dispose operation must always scan the free list. Second, remove the backward pointer and singly link the free list. Now, the free list can be scanned only forward. Currently, Dispose scans the free list from top to bottom in order to minimize the average depth of a scan; a block being disposed would seem to be nearer the top of the heap (a test of this supposition is necessary, cf., [S77]). Finally, remove the lower boundary word. This lower boundary word contains the actual size of the block which may be slightly larger than the requested block. Remember that while a free block is being allocated if the upper portion is too small to fit on the free list, the entire block is allocated. Therefore, the elimination the lower boundary word is not recommended.

Alternately, other methods of allocating small size blocks could be explored. Architectures which have large word sizes (32..64 bits) and restricted byte addressing exhibit a greater memory-space overhead when small blocks are requested. One possible method (described using a 16-bit architecture) allocates a larger block, e.g., 16 words, and allocates successive requests of one word from this same block; an additional word in the block would "bit map" the allocated portions. When the block is full, another 16-word block would be allocated. This method would require a separate free list of these partially allocated blocks. This two-tier structure could be considered for 2, 3,... word blocks, also. Such an arrangement of heap structure could reduce memory-space overhead for small blocks while maintaining the advantages of boundary tags. Other improvements in the boundary-tag module may be possible in a different implementation environment.

Extensions

The boundary-tag module provides a fully general facility, permitting all typical uses of memory management. The heap becomes a perfect place to store objects whose size is run-time dependant.

The run-time system can make extensive use of the heap for I/O buffers, queues, etc. Small processor systems can use the heap for external code swapping instead of using the traditional overlay scheme. Demand paging (with random access files) can be used for virtual arrays and data base files.

The Pascal set type need not be restricted to the typical 64 or 256 elements.

Extensions to standard Pascal (i.e., dynamic arrays, strings, etc.) are easily implemented. For example, an Allocate procedure has been written with which a program can request any size block from the heap at run time. Allocate has been used to implement dynamic arrays accessed via a pointer.

The boundary-tag module provides the programmer with a powerful and efficient heap structure that not only implements standard Pascal effectively, but also permits applications that extend Pascal´s scope.

Acknowledgment

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Appendix

Notes

--The Pascal code in Appendixes A and B closely mirrors the actual run-time library sources which are in Macro-11 assembler code. The original New and Dispose Pascal sources are translated from OMSI-Pascal´s run-time library.

--Extensions to standard Pascal are used.

(1) Pointer arithmetic is used where necessary. A pointer is evaluated as a positive 16-bit integer, i.e., range 0..64K. Although addresses are actually in bytes, word addressing is generally used. The comment, {^}, at the left margin marks pointer arithmetic.

(2) The construct, "@"<identifier>, evaluates as the address of the storage location where the named object, <identifier>, is stored. Those familiar with OMSI-Pascal will recognize this extension. The comment, {@}, at the left margin marks this usage.

--In Appendix D, much of the documentation text has been removed. Most of the information has been covered in the body of this paper.

--Persons wishing to install the boundary-tag module in their OMSI-Pascal should note that file open code (in S3 or SUPOPN) uses storage on the heap without calling New. This code should be changed so that storage is allocated by an explicit call to New.

```
{-------------------------------------------------------------------------------}
{-------------------Appendix A--Original New and Dispose-------------------}

     type
       blockptr = ^block;
       block = record
                   next   : blockptr;  {--link to next free block--}
                   bsize  : integer;   {--size in words of block--}
                   filler : array [3..bsize] of word
               end;
     var
       Free,               {--pointer to beginning of free list--}
       Kore : blockptr;  {--pointer to beginning of unused area--}

     function New (size{in words} : integer) : blockptr;
         {--calling sequence: P := New(size)--}
       var
         scan, lastscan : blockptr;
         i : integer;
       begin{New}
         scan := nil;
         if ( (Free <> nil) and (size >= 2{words}) )
          then   {--free list is not empty--}
           begin  {--search for exact-fit--}
{@}          lastscan := @Free;  {--i.e., lastscan^ = Free--}
             scan := Free;
             while ( (scan^.bsize <> size) and (scan <> nil) ) do
               begin
                 lastscan := scan;
                 scan := scan^.next
               end
           end;

         if ( (scan <> nil) and (size >= 2{words}) )
          then  {--free block found, unlink it from list--}
             lastscan^.next := scan^.next
          else  {--no free block found or size is 1 word--}
           begin  {--extend heap for new block--}
             scan := Kore;
{^}          Kore := Kore + size;
             if (Kore >= Stack_Pointer)
              then  {--collision with stack--}
                 fatal_error('Heap overwriting Stack')
           end;

         New := scan;  {--return address--}
         {--clear the new block--}
         for i:=size downto 1 do  scan^.filler[i] := 0
       end{New};

     procedure Dispose (P : blockptr; size{in words} : integer);
       var
         scan : blockptr;
       begin{Dispose}
         if ( (P <> nil) and (size >= 2{words}) )
             {--no action for 1 word block--}
          then
           begin
             scan := P;             {--set up free block--}
             scan^.bsize := size;
             scan^.next  := Free;
             Free := scan;        {--link to beginning--}
{@}          scan := @Free;       {--     of free list--}

             {--search free list to release blocks from heap--}
             while (scan^.next <> nil) do
{^}              if ( (scan^.next + scan^.next^.bsize) = Kore )
                  then  {--release block and try again--}
                   begin
                     Kore := scan^.next;
                     scan^.next := scan^.next^.next;
{@}                  scan := @Free
                   end
                  else
                     scan := scan^.next
           end
       end{Dispose};

{-------------------------------------------------------------------------------}
{------------------Appendix B--Boundary-Tag New and Dispose------------------}

     const
       alloc = true;  {--bit set--}
       freed = false; {--bit clear--}
     type
       blockptr = ^block;
       block = record
                   lsize : integer,   {--only bits<1..15>--}
                   ltag  : boolean;   {--only bit<0>--}
                   next  : blockptr;  {--up link by address--}
                   prev  : blockptr;  {--down link by address--}
                   filler: array [3..lsize] of word;
                   usize : integer,   {--only bits<1..15>--}
                   utag  : boolean    {--only bit<0>--}
               end;
     var
       Free,              {--pointer to boundary block at bottom of heap--}
       Kore: blockptr;  {--pointer to boundary block at top of heap--}

     function New (size{in words} : integer) : blockptr;
       var
         scan, remscan : blockptr;
         i : integer;

       procedure initialize_heap;
         begin  {--only called once, to set up boundary blocks--}
{^}        Free := Kore + 1{word};
           Free^.lsize := 2{words},  Free^.ltag := alloc;
           Free^.next  := Free;
           Free^.prev  := Free;
           Free^.usize := 2{words},  Free^.utag := alloc;
{^}        Kore := Kore + 4{words};
           Kore^.lsize := 0         ,  Kore^.ltag := freed;
         end;

       begin{New}
         if (size < 2{words})       {--a request of one word--}
          then  size := 2{words};   {--will return two words--}

         scan := Free;
```

```
   if (Free = nil)
    then  {--this is the first New call--}
      initialize_heap;
    else  {--search free list for first-fit--}
      repeat
          scan := scan^.next
      until ( (scan = Free) or (scan^.lsize >= size) );

   if (scan = Free)
    then  {--did not find a large enough free block--}
     begin {--must increase heap size--}
{^}   scan := Kore + 1{word};
{^}   Kore := Kore + size + 2{words};
      {--stack is moved for some system calls--}
{^}   if ( (Stack <= Kore) and (Stack > Free) )
       then  {--collision with stack--}
         fatal_error(´Out of Memory´);
      Kore^.lsize := 0,  Kore^.ltag := freed;
     end

   else if ( scan^.lsize >= (size + 2{words} + 2{words}) )
    then {--found a free block that is too large--}
     begin {--split into remainder--}
{^}   remscan := scan + size + 2{words};
      remscan^.usize := scan^.usize - size - 2{words},
      remscan^.utag  := freed;
      remscan^.lsize := remscan^.usize,
      remscan^.ltag  := remscan^.utag;

      remscan^.next  := scan^.next;
      remscan^.prev  := scan^.prev;

      remscan^.next^.prev := remscan;
      remscan^.prev^.next := remscan
     end

    else  {--found a free block just about the right size--}
     begin {--use the entire block--}
      size := scan^.lsize;
      scan^.next^.prev := scan^.prev;
      scan^.prev^.next := scan^.next
     end;

   New := scan;
   scan^.lsize := size,  scan^.ltag := alloc;
   scan^.usize := size,  scan^.utag := alloc;
   {--clear the new block--}
   for i:=size downto 1 do  scan^.filler[i] := 0
  end{New};

 procedure Dispose (P : blockptr);
   {--do not need size parameter because--}
   {--boundary words contain actual size--}
  var
   LA, UA, scan : blockptr;
  begin{Dispose}
   if ( (P < Free) or (P > Kore) )      {--OMSI permits pointers--}
    then warning(´not a heap pointer´)  {--  to non-heap objects--}

   else if ( (P <> nil) and (P^.ltag <> freed) )
```

```
      {--block better not be free already--}
    then
     begin
      P^.ltag := freed;
      P^.utag := freed;
{^}   LA := P - 2{words} - LA^.usize;  {--lower adjacent of P--}
{^}   UA := P + P^.lsize + 2{words};   {--upper adjacent of P--}

      if (LA^.utag = freed)
       then  {--merge P with LA--}
        begin
         LA^.lsize := LA^.lsize + P^.lsize + 2{words};
         LA^.usize := LA^.lsize;
         P := LA
        end;

      if (UA^.ltag = freed)
       then  {--decrement or merge?--}
         if (UA = Kore)
          then  {--decrement Kore--}
           begin
            if (P = LA)
             then  {--remove P from free list--}
              begin
               P^.prev^.next := Free;
               Free^.prev := P^.prev
              end;
{^}         Kore := P - 1{word};
            Kore^.lsize := 0,  Kore^.ltag := freed
           end
          else  {--merge P with UA--}
           begin
            if (P <> LA)
             then  {--also link P to previous--}
              begin
               P^.prev := UA^.prev;
               P^.prev^.next := P
              end;
            P^.next  := UA^.next;
            P^.lsize :=  P^.lsize + UA^.lsize + 2{words};
            P^.usize :=  P^.lsize;
            P^.next^.prev := P
           end

      else if (P <> LA)
       then {--must search to insert P in order--}
        begin
         scan := Free;
         repeat
             scan := scan^.prev  {--search from top to bottom--}
{^}      until (scan < P);
         P^.next := scan^.next;
         scan^.next := P;
         P^.prev := scan;
         P^.next^.prev := P
        end
     end
  end{Dispose};
```

```
{-----------------------------------------------------------------------}
{--------------------Appendix C--Remark on Error Handling---------------------}
```

Error handling receives only brief mention since its implementation depends on the facilities of the total Pascal system; however, a few problems with memory management and pointers, in general, are worth consideration (cf., [FL77]).

Correct operation depends on the integrity of the information stored to manage memory; a program that writes outside of an allocated block can corrupt management information. To prevent corruption, bounds checking should be incorporated in the Pascal implementation (bounds checking is available in OMSI-Pascal V1.1). However, a few additional tests in the boundary-tag module may provide information on the cause of a failure and possibly show how to continue program execution.

During Dispose, a block's upper and lower boundary words can be compared; a difference indicates an out-of-bounds access. The size parameter, which approximates the actual block size, can be used to examine adjacent blocks and possibly to reconstruct the boundary words. In addition, since the free list is ordered, the pointers can be checked for proper order. With a short free list, these tests would not incur a great time overhead. If the free-list links have been overwritten, the entire heap could be scanned by use of the size field in the boundary words. Sometimes regeneration of the free-list links and correction of mismatched boundary words may be possible; in most cases though, little can be done, except to terminate program execution.

Dangling pointer references also pose a problem. Compiler generated code passes the address of the block to be disposed and leaves the pointer to this block unchanged. In other words, the pointer points to a free block giving the program direct access to the free list. Dispose should be able to reference the pointer so that its value can be set to nil. When there are multiple pointers to the same block, however, the other pointers continue to reference the free list, even though the disposed pointer may be set to nil. A solution requires redesign of pointer implementation.

```
;-----------------------------------------------------------------------;
;--------------Appendix D--Boundary-Tag New and Dispose, Macro-11--------------;

        .TITLE NEWDIS : NEW&DISPOSE w/boundary tag
        .IDENT /V0101C/
        .ENABL LC,REG

   .REPT 0

        Module Version : 1.1c: 20-Jan-80  ;  Tested : 26-Jan-80

        Module Version : 1.1b: 17-Nov-79  ;  Tested : 24-Nov-79
        Module Version : 1.1 : 16-Mar-79  ;  Tested : 30-Mar-79
        Module Version : 1.0 : 03-Oct-78  ;  Tested : 16-Oct-78

        Branko J Gerovac
        Eunice Kennedy Shriver Center
        200 Trapelo Road
        Waltham, Massachusetts  02154
        (617) 893-3500 ext 157

   .ENDR
;
```

```
;- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
;
        .SBTTL  Heap Initialization
;
;  Initag Version : 1.0 : 03-Oct-78
;
        .PSECT  $$$NEW          ;                                          !1.1
;
        .GLOBL  $FREE,$KORE     ;  {# import global pointers #}
;
INTHEP:                         ;  proc init_heap;
        MOV     R0,-(SP)        ;  begin
        MOV     @#$KORE,R0      ;    {# R0==$KORE #}{ $KORE is first of heap }
        MOV     #5.,(R0)+       ;    $FREE^.lsize:=2w , $FREE^.ltag:=alloc;
        MOV     R0,@#$FREE      ;    $FREE:=$KORE+1w;
        MOV     R0,(R0)         ;    $FREE^.bot:=$FREE;
        MOV     (R0)+,(R0)+     ;    $FREE^.top:=$FREE;
        MOV     #5.,(R0)+       ;    $FREE^.usize:=2w , $FREE^.utag:=alloc;
        MOV     R0,@#$KORE      ;    $KORE:=$KORE+4w;
        CLR     (R0)            ;    $KORE^:=0;
        MOV     (SP)+,R0        ;
        RTS     PC              ;  end;
;
;- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
;
        .SBTTL  $B70 : New with boundary tag
;
;  Newtag Version : 1.1c: 20-Jan-80 ; change in memory overflow test
;  Newtag Version : 1.1b: 17-Nov-79 ; change in memory overflow test
;  --option call to debugger, Pascal V1.1
;  Newtag Version : 1.1 : 16-Mar-79 ; minor changes to improve speed
;  Newtag Version : 1.0 : 03-Oct-78
;
;  Calling Sequence :
;
;               ;    NEW(P);
;
;                       MOV     SIZE,-(SP)      ; even size in bytes
;                       JSR     PC,$B70         ;
;                       MOV     (SP)+,P(Rx)     ; register 5 or 6 offset
;
;  Stack Image during call :    |_______________|
;                               |_____size______| <--- return new_block address
;                               |____PC_ret_____|
;                               |____R0_sav_____|
;                               |____R1_sav_____|
;                               |____R2_sav_____|
;                               |____R3_sav_____| <--- SP
;                               |               |
        .PSECT  $$$NEW          ;                                          !1.1
        .ENABL  LSB             ;                                          !1.1
;
        .GLOBL  $B70,$NEW       ;  {# export global procedure #}
        .GLOBL  $FREE,$KORE     ;  {# import global pointers  #}
        .GLOBL  ERR1.1          ;  {# import global conditional #}          !B
        .MCALL  .EXIT,.PRINT    ;  {# import system macros    #}
;
;                               ;  { for Pascal V1.1, debugger, set true }  !B
        .IIF NDF,ERR1.1,ERR1.1=0;  (undef(err1.1)|err1.1=false);            !B
;
```

```
        .IF NE, ERR1.1          ; #if (errl.1<>0) #then                      !B
        .GLOBL  RTERR           ;     {# import global proc #}               !B
        .GLOBL  COROVR          ;     {# import global label #}              !B
        .ENDC                   ; #endif                                     !B
$B70:
$NEW:                           ; proc NEW(size:int):pointer;
        MOV     R0,-(SP)        ; begin
        MOV     R1,-(SP)        ;
        MOV     R2,-(SP)        ;
        MOV     R3,-(SP)        ;   {# save registers #}
        MOV     10.(SP),R0      ;   {# R0==size #}
        CMP     R0,#4.          ;   if size < 2w
        BHIS    1$              ;     then
        MOV     #4.,R0          ;       size:=2w
1$:                             ;   endif;
        MOV     @#$FREE,R1      ;   {# R1==scan #}
        MOV     R1,R3           ;   {# R3==$FREE #}
;                               ;   if (scan:=$FREE)=nil
        BNE     2$              ;     then
        JSR     PC,INTHEP       ;       init_heap;
        BR      4$              ;       goto alloc_from_$KORE
2$:                             ;   endif;
3$:                             ;   repeat
        MOV     (R1),R1         ;     scan := scan^.next
;                               ;   until
        CMP     R1,R3           ;      (
        BEQ     4$              ;        scan=$FREE
        CMP     -2.(R1),R0      ;      or                                  !1.1
        BHIS    5$              ;        scan^.size>=size                  !1.1
        BR      3$              ;      );
4$:                             ;   if scan=$FREE
;                               ;     then   allocate_from_$KORE :
        MOV     @#$KORE,R1      ;
        TST     (R1)+           ;       scan:=$KORE+1w;
        MOV     R1,R2           ;       {# R2==$KORE #}                      !B
        TST     (R2)+           ;                                            !B
        ADD     R0,R2           ;                                            !B
        MOV     R2,@#$KORE      ;
        BCS     OUTMEM          ;       if carry_set($KORE:=$KORE+size+2w)   !C
        CMP     SP,R2           ;          or ((SP<=$KORE)                   !B
        BHI     41$             ;              and                           !B
        CMP     SP,@#$FREE      ;                 (SP>$FREE))                !B
        BHI     OUTMEM          ;             then error(out of memory)      !B
41$:                            ;       endif;                               !B
        CLR     (R2)            ;       $KORE^:=0;
        BR      7$              ;
5$:                             ;
        MOV     #8.,R2          ;                                          !1.1
        ADD     R0,R2           ;                                          !1.1
        CMP     -(R1),R2        ;   else if scan^.size >= size+2w+2w       !1.1
        BLO     6$              ;     then                                 !1.1
        MOV     (R1)+,R2        ;       alloc_lower_portion_of_scanblock :
        MOV     R2,R3           ;                                          !1.1
        SUB     R0,R3           ;                                          !1.1
        SUB     #4.,R3          ;       {# R3==scan^.size-size-2w #}       !1.1
        ADD     R1,R2           ;       {# R2==remscan #}
        MOV     R3,(R2)         ;      remscan^.usize:=scan^.size-size-2w; !1.1
        SUB     R3,R2           ;                                          !1.1
        MOV     R3,-2.(R2)      ;       remscan^.lsize:=remscan^.usize;    !1.1
        MOV     (R1)+,R3        ;       {# R3==scan^.next #}
```

```
        MOV     R3,(R2)+        ;       remscan^.next:=scan^.next;
        MOV     (R1),(R2)       ;       remscan^.prev:=scan^.prev;
        CMP     -(R1),-(R2)     ;
        MOV     R2,2.(R3)       ;       remscan^.next^.prev:=remscan;
        MOV     R2,@2.(R2)      ;       remscan^.prev^.next:=remscan;
        BR      7$              ;
6$:                             ;   else   allocate_entire_scanblock :
        MOV     (R1)+,R0        ;       size:=scan^.size;                  !1.1
        MOV     (R1),@2.(R1)    ;       scan^.prev^.next:=scan^.next;
        MOV     (R1),R2         ;
        MOV     2.(R1),2.(R2)   ;       scan^.next^.prev:=scan^.prev;
7$:                             ;   endif;
;                               ;
        MOV     R1,10.(SP)      ;   New:=scan;
        INC     R0              ;
        MOV     R0,-(R1)        ;   scan^.lsize:=size, scan^.ltag:=alloc;
        ADD     (R1)+,R1        ;
        DEC     R1              ;
        MOV     R0,(R1)         ;   scan^.usize:=size, scan^.utag:=alloc;
        CCC                     ;   {# clear carry et al #}
        ROR     R0              ;
8$:                             ;   for i:=size_in_words downto 1 do
        CLR     -(R1)           ;     scan^[i]:=0
        SOB     R0,8$           ;   endfor;
;                               ;
        MOV     (SP)+,R3        ;   {# pop registers #}
        MOV     (SP)+,R2        ;
        MOV     (SP)+,R1        ;
        MOV     (SP)+,R0        ;
        RTS     PC              ; end;
OUTMEM:                         ;
        .IF NE, ERR1.1          ; #if (errl.1<>0) #then                      !B
        JSR     R5,RTERR        ;     rterr(corovr)                          !B
        .WORD   COROVR          ;                                            !B
        .IFF                    ; #else                                      !B
        .PRINT  ERRO            ;     print('out of memory')
        .EXIT                   ;
ERRO:                           ;
        .ASCIZ  /?Paslib-F-NEW-Out of Memory/
        .EVEN
        .ENDC                   ; #endif                                     !B
;
        .DSABL  LSB             ;                                          !1.1
;
;- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
;
        .SBTTL  $B72 : Dispose with boundary tag
;
;  Distag Version : 1.1 : 16-Mar-79 ; check for pointer not to heap
;  Distag Version : 1.0 : 03-Oct-78
;
;  Calling Sequence :
;
;               ;    DISPOSE(P);
;
;                       MOV     P(Rx),-(SP)     ; register 5 or 6 offset
;                       MOV     SIZE,R0         ; even size in bytes
;                       JSR     PC,$B72         ;
;               ;
;
```

```
;
;  Stack Image during call :      |_______________|
;                                 |__block_addr___|
;                                 |_____PC_ret____|
;   RO |_______size______|        |_____R1_sav____|
;                                 |_____R2_sav____|  <--- SP
;                                 |               |
;
        .PSECT  $$$DIS          ;                                        !1.1
        .ENABL  LSB             ;                                        !1.1
;
        .GLOBL  $B72,$DISPO     ;  {# export global procedure #}
        .GLOBL  $FREE,$KORE     ;  {# import global pointers  #}
        .GLOBL  WRND1           ;  {# import global conditional #}       !1.1
        .MCALL  .PRINT          ;  {# import system macro #}             !1.1
;
        .IIF NDF,WRND1,WRND1=1  ;  (undef(warn_dl)|warn_dl=true);        !1.1
;
$B72:
$DISPO:                         ;  proc DISPOSE(P:pointer);
        MOV     R1,-(SP)        ;  begin
        MOV     R2,-(SP)        ;
        MOV     6.(SP),R1       ;    {# R1==P #}
        BEQ     27$             ;    if P=nil then goto return endif;
;                               ;
        .IF NE, WRND1           ;    #if (warn_dl<>0) #then               !1.1
        CMP     R1,@#$FREE      ;      if P<$FREE                         !1.1
        BLO     NOHEAP          ;       or                                !1.1
        CMP     R1,@#$KORE      ;         P>$KORE                         !1.1
        BHI     NOHEAP          ;        then warn(not a heap ptr) endif; !1.1
        .ENDC                   ;    #endif                               !1.1
;                               ;
        BIT     #1.,-(R1)       ;    { use physical size }
        BEQ     27$             ;    if P^.ltag=free then goto return endif;
;                               ;
        DEC     (R1)            ;    P^.ltag:=free;
        MOV     R1,R0           ;    {# R0==LA==lower_adjacent(P) #}
        MOV     (R1)+,R2        ;
        ADD     R1,R2           ;
        DEC     (R2)+           ;    P^.utag:=free;
;                               ;    {# R2==UA==upper_adjacent(P) #}
        BIT     #1.,-(R0)       ;    if LA^.utag=free                     !1.1
        BNE     21$             ;      then
        SUB     (R0),R0         ;        { merge(LA,P) }
        ADD     -(R1),-(R0)     ;
        ADD     #4.,(R0)        ;        LA^.lsize:=LA^.lsize+P^.lsize+2w;
        ADD     (R1)+,R1        ;
        MOV     (R0)+,(R1)      ;        LA^.usize:=LA^.lsize;
        MOV     R0,R1           ;        P:=LA
21$:                            ;    endif;
;                               ;
        BIT     #1.,(R2)        ;    if UA^.ltag=free
        BNE     25$             ;      then
        CMP     R2,@#$KORE      ;        if UA=$KORE
        BNE     23$             ;          then  { merge(P,$KORE) }
        CMP     R1,R0           ;            if P=LA
        BNE     22$             ;              then
        MOV     (R1),@2.(R1)    ;                P^.prev^.next:=P^.next;
        MOV     (R1),R2         ;
        MOV     2.(R1),2.(R2)   ;                P^.next^.prev:=P^.prev;
22$:                            ;              endif;
        CLR     -(R1)           ;              (P-1w)^:=0;                !1.1
        MOV     R1,@#$KORE      ;              $KORE:=P-1w;
        BR      27$             ;
23$:                            ;            else  { merge(P,UA) }
        CMP     R1,R0           ;              if P<>LA
        BEQ     24$             ;                then
        MOV     4.(R2),2.(R1)   ;                  P^.prev:=UA^.prev;
        MOV     R1,@2.(R1)      ;                  P^.prev^.next:=P
24$:                            ;              endif;
        MOV     2.(R2),(R1)     ;              P^.next:=UA^.next;
        ADD     (R2),-(R1)      ;
        ADD     #4.,(R1)        ;              P^.lsize:=P^.lsize+UA^.lsize+2w;
        ADD     (R2)+,R2        ;
        MOV     (R1)+,(R2)      ;              P^.usize:=P^.lsize;
        MOV     (R1),R2         ;
        MOV     R1,2.(R2)       ;              P^.next^.prev:=P;
        BR      27$             ;
25$:                            ;            endif;
        CMP     R1,R0           ;      else if P<>LA
        BEQ     27$             ;        then  { scan and insert(P) }
        MOV     @#$FREE,R2      ;          scan:=$FREE;  {# R2==scan #}
26$:                            ;          repeat
        MOV     2.(R2),R2       ;            scan:=scan^.prev
        CMP     R2,R1           ;          until
        BHIS    26$             ;            (scan<P);
        MOV     (R2),(R1)       ;          P^.next:=scan^.next;
        MOV     R1,(R2)         ;          scan^.next:=P;
        MOV     R2,2.(R1)       ;          P^.prev:=scan;
        MOV     (R1),R2         ;
        MOV     R1,2.(R2)       ;          P^.next^.prev:=P;
27$:                            ;      endif;
        MOV     (SP)+,R2        ;    return :
        MOV     (SP)+,R1        ;
        MOV     (SP)+,(SP)      ;
        RTS     PC              ;    end;
;                               ;
;                               ;
        .IF NE, WRND1           ;                                         !1.1
NOHEAP:                         ;                                         !1.1
        .PRINT  WRN1            ;                                         !1.1
        BR      27$             ;                                         !1.1
WRN1:                                                                     !1.1
        .ASCIZ  /?Paslib-W-DISPOSE-not a heap pointer/  ;                 !1.1
        .EVEN                   ;                                         !1.1
        .ENDC                   ;                                         !1.1
;
        .DSABL  LSB             ;                                         !1.1
;
;----------------------------------------------------------------------------;
;----------------------------------------------------------------------------;
```

UNIVERSITETET I OSLO

EDB - SENTRET
POSTBOKS 1059 - BLINDERN
OSLO 3 - NORWAY

PHONE (47) - 2 - 46 68 00
BLINDERN, June 18, 1980

Mr. Richard J. Cichelli
ANPA
1350 Sullivan Trail,
P.O. Box 598, Easton
Pennsylvania 18042

Dear Mr. Cichelli,

We are of course happy to submit the QPP article for publication in Pascal News. (Actually, being a member of PUG myself, I should have thought of sending you the article earlier.)

Enclosed is a copy of the SIGPLAN article together with the code implementing the external procedures on the Nord.

Sincerely,

Terje Noodt

Terje Noodt

A Simple Extension of Pascal for Quasi-Parallel Processing

Terje Noodt
Dag Belsnes
Computing Center
University of Oslo

1 Introduction

The University of Oslo has for a number of years been engaged in the development of systems for data communications. The main work investments have been the design of suitable protocols, and the implementation of these in network node machines. Most of the node machines have been of the Nord family, produced by the Norwegian manufacturer Norsk Data A.S.

There exists no suitable language on the Nord for programming real-time stand-alone systems. Therefore, all programming has been done in assembly code. Even though we have felt the need for a high-level language tool, the cost of developing and/or implementing a suitable language was thought to be high.

Some time ago, we looked into the possibility of using the existing Pascal compiler for our purposes. It proved that a simple but usable language tool could be made from Pascal very cheaply. We have called this extension of Pascal for QPP (Quasi-Parallel Pascal). This article describes QPP and its implementation.

2 Basic primitives

The present section first discusses how to establish a suitable process concept. Then the sequencing of processes is treated.

2.1 Processes

The most important task in the design of QPP was to establish a process concept without deviating from Standard Pascal. In this context, a process is a sequential program together with a set of data on which the program operates. We call this set of data the attributes of the process.

In several respects, the Pascal procedure has the characteristics of a process. We have managed to use the procedure as a process, by overcoming the following two obstacles:

1. It is necessary that several processes can be executed simultaneously - that is, the processes must be able to have active phases in quasi-parallel.

2. It must be possible for processes to exchange information - that is, one process must be able to access the attributes of another process.

To transform the procedure concept into a process, point 1. requires that the attributes of a "process-procedure" must be retained while it has a passive phase. That is, a "process-procedure" cannot execute on the stack top as usual, but must have some permanent space in memory.

Point 2. requires some form of looking "into" a procedure. In Pascal, a similar mechanism is given by the record concept. Consider the following program fragment:

```
type
  PROCESS = record
              x, y: T
            end;
  PTRPROCESS = ↑PROCESS;
var
  p: PTRPROCESS;

procedure processprogram;
var
  LOCALS: PROCESS;
begin
  with LOCALS do
  begin
    . . .
  end
end
```

Within the with statement in processprogram the attributes x and y may be accessed directly.

A process is created by calling the function

```
function NEWPROCESS(procedure PROG);
```

This function allocates data space for the procedure PROG on the heap. The function value is a pointer to the record containing the process attributes. In reality, the pointer is a reference to the inside of the procedure object. The Pascal system, however, treats the pointer as if it were generated by the NEW function.

The main program (or another process) may access the attributes through the pointer generated by NEWPROCESS.

The following program fragment shows how a process is generated, and its attributes accessed from the outside:

```
p := NEWPROCESS(processprogram);
. . .
p↑.y := . . .
. . .
with p↑ do
  if x = . . .
```

Several processes of the same type may be generated as follows:

```
var
  p1, p2: PTRPROCESS;
  . . .
  p1 := NEWPROCESS(processprogram);
  p2 := NEWPROCESS(processprogram);
```

Processes of different types may be defined by declaring different PROCESS types, or by defining a variant part for each type of process within PROCESS.

Thus, a usable process concept has been established by

1. Implementation of the function NEWPROCESS. In Nord-1Ø Pascal this is an assembly routine of 15 instructions.

2. Requiring that the programmer stick to the following rules:

   a. Define a record type PROCESS which contains those variables of a process which are to be visible from outside the process.

   b. Declare a variable LOCALS of type PROCESS as the first variable within the process procedure.

   c. Surround the statements of the procedure by
      with LOCALS do begin . . . end

2.2 Sequencing

It must be possible to start and stop the execution of any process, in order that operations occur in the sequence required by the actual application. For this purpose, two operations are implemented (these are modelled after the corresponding primitives in Simula 67):

```
procedure RESUME(p: PTRPROCESS);
```

This procedure transfers control from the caller to the process given by the actual parameter p. The execution of p is resumed at the place where the process last became passive. The caller becomes passive.

```
procedure DETACH;
```

When a process p calls DETACH, it becomes passive. Control goes to the last process x which called RESUME(p).

The following method has been used to implement RESUME and DETACH efficiently and with ease.

A Pascal procedure object will normally contain one location for the return address (RA), and one location for the dynamic link (DL). Let CP be a pointer to the currently active process, and consider the main program to be a process with the name MAIN.

The operation RESUME(p) leaves the current program address in CP.RA, and the address of the currently active object (which may be CP itself or an ordinary pr ocedure called by CP) in CP.DL. p.DL becomes the new active object, and execution is resumed at p.RA.

The DETACH operation is restricted to be used to give control back to the main program. It leaves the current program address in CP.RA, and the address of the currently active object in CP.DL. MAIN.DL becomes the new active object, and execution is resumed at MAIN.RA.

The DL location of a process is zero while the process is executing. Thus, CP is found by following the DL chain until DL equals zero. The following function is provided to enable the Pascal program to find CP:

```
   function THISPROCESS: PTRPROCESS;
```

2.3 Summary

With a very small effort a primitive but usable process concept has been implemented within Pascal. On the Nord-1Ø, the routines NEWPROCESS, RESUME, DETACH and THISPROCESS consist of ca 6Ø assembly instructions. No changes have been made to the Pascal compiler or the Pascal run-time library. Although Pascal may operate differently on other computers, the authors believe that our method of implementation may be adapted to most Pascal systems.

On the Nord-1Ø, an ordinary procedure called from a process will execute in the memory space allocated to that process. This requires that the process object be large enough to accommodate such procedure calls. We have solved this problem by letting NEWPROCESS have one extra parameter, giving the largest necessary space for the process.

3 Process Scheduling

Section 2 defines and indicates how to implement a process concept and the basic primitives for process sequencing. To program a real-time system or a simulation model, some additional concepts are needed. Also in this case SIMULA 67 is used as a source of inspiration. The new programming platform contains:

- a system time concept.
- a "sequencing set" containing the processes scheduled for future execution.
- primitives for process scheduling.

In this section we show how these concepts may be implemented in Standard Pascal, using the basic primitives of section 2.

3.1 Simulated time, Real time

In the case of simulations, the system time is introduced as in SIMULA, but in a real-time environment the system time corresponds closely to the time defined by the computer´s real-time clock. The system time is represented by a variable in the main program:

```
          SYSTIME:real;
```

The execution of an active phase of a process, called an event, is regarded as not consuming system time. That is, SYSTIME is only updated between the events. How SYSTIME is updated is described below.

3.2 The sequencing set

A process may be scheduled for the execution of a future event. An event is associated with a system time, indicating when the event will occur. This time is represented by a variable local to each process:

```
          EVTIME:real;
```

All scheduled processes are collected in a set, the sequencing set, sorted on the EVTIME variable. The sequencing set is represented by a main program variable:

```
          SQS:PTRPROCESS;
```

which points to the first member of the set, and a variable

```
          NEXTPR:PTRPROCESS;
```

in each process pointing to the next element of the sequencing set.

When an active phase of a process ends, the first process P in the SQS will be the next process to execute an event. The value of SYSTIME is changed to EVTIME of P. If simulated time is used, the simulation is carried on by resuming the process P.

In a real-time system the new value of SYSTIME is compared with the computer´s clock. If the difference is positive, the Pascal program makes a monitor call to release the use of the

CPU for the given amount of time. On return from the monitor call the procedure RESUME(P) is called.

3.3 Process scheduling

The following procedures define a small but convenient set of operations for discrete event scheduling. All procedures are written in Standard Pascal. The amount of Pascal code is about 40 lines. For a detailed description see the appendix.

procedure PASSIVATE;

The caller process ends its active phase, and the next event is given by the first element of the SQS. SYSTIME is updated, and in the real-time case the program may request a pause before the next process is resumed.

procedure HOLD(del:real);

Equivalent to PASSIVATE, except that the caller is put into the SQS with an event time equal to SYSTIME+del.

procedure ACTIVATE(p:PTRPROCES; del:real);

The process p is scheduled to have an event at the time SYSTIME+del.

procedure CANCEL(p:PTRPROCESS);

If the process p is scheduled to have an event, this event is cancelled. That is, p is removed from the SQS.

3.4 Summary

Based on the basic primitives discussed in section 2, we have defined a set of additional primitives suitable for discrete event scheduling. These primitives are implemented by Standard Pascal procedures and data structures. The system time concept is introduced in two variations: simulated time and real time. In the implementation the difference between the two time concepts is only visible as a small modification of the procedure PASSIVATE. An important consequence is that it is possible to test out a program by simulation and afterwards use the same program as a part of a real time system.

4 Concluding remarks

As an example, the Bounded Buffer problem has been programmed in the appendix.

At the University of Oslo, QPP has been used to program the UNINETT node. UNINETT is a computer network of the central computers of all universities in Norway, plus several other governmental computers. Each institution has a node machine which hooks one or more computers into the network. At the University of Oslo, this node is a Nord-10. The size of the UNINETT node program is about 2200 lines of QPP code. In the development of this program, keeping to the restrictions of QPP was neither hampering nor the cause for any serious problems. The UNINETT project has shown that a considerable amount of development time may be gained by going from assembly code to a "primitive" high-level language tool. In cases where a full-fledged language tailored to the actual application (such as Concurrent Pascal) is not available, there seems to be good reason to select a solution such as ours.

The UNINETT node program was developed on a Nord-10 running the MOSS operating system. The first step in testing the program was to run it under MOSS as a simulation, using simulated time. Then the program was run in real time under MOSS. Finally, the program was transported to the UNINETT node machine, where it runs in real time. The node machine has a rudimentary operating system only, which supports stand-alone systems of this kind. The small size of the code which implements the QPP process primitives, has allowed us to easily make different versions to adapt to the environment in which the UNINETT program was to be run. It has proved very valuable to run the program as a simulation before it was run in real time. Development time was also saved by testing under an operating system with utilities such as interactive debugging, a file system etc. The errors remaining after transporting the program to the node machine have been few.

The reader who compares QPP with for instance Concurrent Pascal, will remark that QPP contains no primitives for the protection of shared data. Such a mechanism could be useful in QPP, but is not strictly necessary. The reason is that processes run in quasi-parallel rather than true parallel. An active phase of a process is regarded to take zero time, and thus is an indivisible operation. Time increases only when control is transferred from one process to another. It is the programmer who decides at which points in the program this may occur.

Appendix

This appendix contains a simple example of the use of QPP. A producer process generates characters which are read by a consumer process. The rate of production/consumption is up to the processes themselves, and in order to remove some of the time dependency between the processes, they are connected by a bounded buffer. However, since the buffer may get full (or empty) there is still need for some synchronization of the processes. This is achieved by the use of the ACTIVATE and PASSIVATE primitives.

The program also contains a complete implementation of the concepts defined in section 3. Names corresponding to concepts and primitives in QPP are written in capital letters, while small letters are used for variables particular for the example.

```
program prodcon;
const
  buflength = 16;
  buflgml = 15;
type

(*  definition of bounded ring buffer  *)

  bufindex = Ø..buflgml;
  buf=record
          p,c:bufindex;
          txt:packed array[bufindex] of char;
    end;
  ptrbuf=↑buf;

(*  definition of the data structure of the processes  *)

  PTRPROCESS=↑PROCESS;
  processtype=(producer,consumer);
  PROCESS=record
      NEXTPR:PTRPROCESS; EVTIME:real; INSQS:boolean;
      case processtype of
          producer:(outbuf:ptrbuf; outcha:char);
          consumer:(inbuf :ptrbuf; incha :char);
    end;

var
  SQS:PTRPROCESS; SYSTIME:real;
    ptrpro,ptrcon:PTRPROCESS;

(**        basic primitives     **)

function NEWP(procedure p; siz:integer):PTRPROCESS; extern;
function THISP:PTRPROCESS; extern;
procedure RESUME(p:PTRPROCESS); extern;
procedure DETACH; extern;
```

```
(**         sequencing routines      **)

procedure INTOSQS(p:PTRPROCESS);
var rp,rpo:PTRPROCESS;
  begin
   with p↑ do
   begin
     rp:=SQS; rpo:=nil;
     while (rp<>nil) and (rp↑.EVTIME<EVTIME) do
     begin rpo:=rp; rp:=rp↑.NEXTPR end;
     if rpo=nil then SQS:=p else rpo↑.NEXTPR:=p;
     NEXTPR:=rp; INSQS:=true
   end;
  end;

procedure CANCEL(p:PTRPROCESS);
var rp,rpo:PTRPROCESS;
  begin
   with p↑ do
   if INSQS then
    begin
      INSQS:=false; rp:=SQS; rpo:=nil;
      while rp<>p do begin rpo:=rp; rp:=rp↑.NEXTPR end;
      if rpo=nil then SQS:=rp↑.NEXTPR else rpo↑.NEXTPR:=rp↑.NEXTPR;
    end;
  end;

procedure PASSIVATE;
var p:PTRPROCESS;
  begin
     p:=SQS; if p=nil then DETACH else SYSTIME:=p↑.EVTIME;
     (* if realtime then monitor call PAUSE(SYSTIME-CLOCK)       *)
     SQS:=p↑.NEXTPR; p↑.INSQS:=false; RESUME(p)
  end;

procedure HOLD(del:real);
var p:PTRPROCESS;
  begin p:=THISP; p↑.EVTIME:=SYSTIME+del; INTOSQS(p); PASSIVATE end;

procedure ACTIVATE(p:PTRPROCESS; del:real);
  begin CANCEL(p); p↑.EVTIME:=SYSTIME+del; INTOSQS(p) end;
```

```
(**         buffer routines   **)

function bufempty(bp:ptrbuf):boolean;
  begin bufempty:=(bp↑.p=bp↑.c) end;
function buffull(bp:ptrbuf):boolean;
  begin buffull:=(((bp↑.p+1) mod buflength)=bp↑.c) end;
function putchar(bp:ptrbuf; ch:char):boolean;
  begin with bp↑ do
     if ((p+1) mod buflength)=c then putchar:=false else
     begin txt[p]:=ch; p:=(p+1) mod buflength; putchar:=true end;
  end;
function getchar(bp:ptrbuf; var ch:char):boolean;
  begin with bp↑ do
     if p=c then getchar:=false else
     begin ch:=txt[c]; c:=(c+1) mod buflength; getchar:=true end;
  end;

(**          processes     **)

procedure pproducer;
var LOCALS:PROCESS;
begin DETACH;
   with LOCALS do
   while true do
    begin
      (*  produce next character  *)
      if bufempty(outbuf) then ACTIVATE(ptrcon,0);
      while not putchar(outbuf,outcha) do PASSIVATE
    end
end;

procedure pconsumer;
var LOCALS:PROCESS;
begin DETACH;
   with LOCALS do
   while true do
    begin
      if buffull(inbuf) then ACTIVATE(ptrpro,0);
      while not getchar(inbuf,incha) do PASSIVATE;
       (*  consume character  *)
    end
end;

(**         main program    **)

begin
   ptrpro:=NEWP(pproducer,100); ptrcon:=NEWP(pconsumer,100);
   new(ptrpro↑.outbuf); ptrcon↑.inbuf:=ptrpro↑.outbuf;
   RESUME(ptrpro)
end.
```

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%                                                                    %
%                       Q P P                                        %
%                                                                    %
%  RUN-TIME ROUTINES TO TRICK THE NORD PASCAL SYSTEM                 %
%  INTO TREATING QUASI-PARALLEL PROCESSES                            %
%                                                                    %
%    (IN THIS VERSION THE RESTRICTION THAT DETACH MAY RELINQUISH     %
%     CONTROL TO THE MAIN PROGRAM ONLY, HAS BEEN REMOVED)            %
%                                                                    %
%    PROGRAMMER: T. NOODT, COMPUTING CENTER, UNIV. OF OSLO           %
%    DATE:       JUNE, 1980                                          %
%                                                                    %
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%
%  NOTE:
%
%  1.  THE NORD-10/100 REGISTERS ARE:
%      P  PROGRAM COUNTER
%      L  LINK REGISTER
%      X  POST-INDEX REGISTER
%      B  PRE-INDEX REGISTER
%      T  TEMPORARY REGISTER
%      A  ACCUMULATOR
%      D  EXTENDED ACCUMULATOR
%  2.  THE B REGISTER CONTAINS A POINTER TO THE CURRENTLY ACTIVE
%      OBJECT + 200 OCTAL.
%  3.  WHEN A ROUTINE IS CALLED, THE PARAMETERS ARE FOUND AT ADDRESS
%      (B) + (A) + N, WHERE N=4 FOR FUNCTIONS, N=3 FOR PROCEDURES.
%  4.  A FUNCTION RESULT IS TRANSFERRED IN A.
%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

RETB=      -2            % RETURN B
RETP=      -1            % RETURN P
STLK=      0             % STATIC LINK
DYLK=      1             % DYNAMIC LINK
                         % POINTS "INWARD" IN PROCESSES
LSC=       2             % LOCAL SEQUENCE CONTROL
PARAM=     4             % RELATIVE LOCATION OF PARAMETERS
SAVB=      10            % SAVE LOCATIONS
SAVL=      11
SAVX=      12

)9BEG
)9LIB      NEWP
)9ENT      NEWP 5PESH
)9EXT      5PNEW
%
%  FUNCTION NEWP(PROCEDURE P; SIZE:INTEGER):PTRPROCESS;
%
%    GENERATE NEW PROCESS
%      P IS THE PROCESS CODE
%      SIZE IS THE OBJECT SIZE
%
NEWP=      *
           SWAP      SA DB
           RADD      SA DB                 % B IS NOW TOP OF STACK
           STA       SAVB,B                % SAVE POINTER TO CALLER OBJECT
           COPY      SL DA
```

```
          STA       SAVL,B              % SAVE POINT OF CALL
          COPY      SB DX
          LDA       PARAM+3,B           % GET SIZE
          AAA       2                   % ADD SPACE FOR RETB AND RETP
          JPL I     (5PNEW              % CALL NEW TO GET OBJECT
          LDX       Ø,B                 % OBJECT POINTER
          AAX       2                   % ADJUST POINTER PAST RETB AND RETP
          LDA       PARAM+1,B           % P´S STATIC LINK
          STA       STLK,X
          LDA       SAVL,B
          STA       RETP,X
          LDA       SAVB,B
          STA       RETB,X
          STZ       DYLK,X              % INDICATE ACTIVE PROCESS
          LDT       PARAM+2,B           % P´S CODE
          AAT       4                   % SKIP FIRST 4 INSTRUCTIONS OF P
                                        % (THEY DO NON-RELEVANT CHECKS)
          COPY      SX DA
          AAA       3                   % "RECORD" POINTER
                                        % (REFERS TO FIRST LOCAL VARIABLE)
          COPY      SA DB
          AAB       175                 % STACK POINTER
          COPY      ST DP               % EXECUTE PROCESS

          )FILL                         % (GENERATE LITERALS)

5PESH=    *         % IGNORE THE USUAL STACK-HEAP OVERFLOW CHECK
          EXIT

)9END

)9BEG
)9LIB     THISP
)9ENT     THISP
%
%  FUNCTION THISP: PTRPROCESS;
%
THISP=    *
          COPY      SB DX
          LDA       DYLK-2ØØ,X          % FOLLOW DYNAMIC LINK
          JAZ       *+3                 % UNTIL IT IS ZERO (=PROCESS FOUND)
          COPY      SA DX
          JMP       *-3
          COPY      SX DA
          AAA       -175                % ADJUST POINTER BY -2ØØ+3
          EXIT
)9END

)9BEG
)9LIB     RESUME
)9ENT     RESUME
%
%  PROCEDURE RESUME(PTR: PTRPROCESS);
%
RESUME=   *
          COPY      SA DX
          LDX       3,X,B               % PTR
          AAX       -3                  % TOP OF OBJECT
          COPY      SL DA
          STA       RETP,X              % RETURN POINT
```

```
          COPY      SB DA
          STA       RETB,X              % RETURN OBJECT
          LDA       DYLK,X              % ACTIVE OBJECT INSIDE PROCESS
          COPY      SA DB
          STZ       DYLK,X              % INDICATE ACTIVE PROCESS
          LDA       LSC,X
          COPY      SA DP               % JUMP

)9END

)9BEG
)9LIB     DETACH
)9ENT     DETACH
%
%  FUNCTION DETACH: PTRPROCESS;
%
DETACH=   *
          COPY      SB DX
          LDA       DYLK-2ØØ,X          % FOLLOW DYNAMIC LINK
          JAZ       *+3                 % UNTIL PROCESS OBJECT IS FOUND
          COPY      SA DX
          JMP       *-3
          AAX       -2ØØ                % ADJUST X TO TOP OF OBJECT
          COPY      SB DA
          STA       DYLK,X              % SET "INWARD" DYNAMIC LINK
          COPY      SL DA
          STA       LSC,X               % SAVE PROGRAM POINT
          LDA       RETB,X              % CALLER´S OBJECT
          COPY      SA DB
          LDT       RETP,X
          COPY      SX DA
          AAA       3                   % PROCESS PTR (FUNCTION RESULT)
          COPY      ST DP               % RETURN TO CALLER

)9END

)9BEG
)9LIB DISPP
)9ENT DISPP
)9EXT     5PDSP
%
%  PROCEDURE DISPP(VAR PTR: PTRPROCESS);
%
%    DISPOSE PROCESS
%
%      MAY BE INCLUDED IF DYNAMIC DEALLOCATION OF PROCESSES IS
%      WANTED, AND THE PASCAL SYSTEM HAS THE DISPOSE PRIMITIVE.
%
DISPP=    *
          COPY      SA DX
          LDX       3,X,B               % GET POINTER TO PTR
          LDA       Ø,X                 % GET PTR
          STZ       Ø,X                 % PTR := NIL
          AAA       -5                  % ADJUST TO TOP OF ALLOCATED OBJECT
          SAX       177
          RADD      SB DX
          STA       Ø,X                 % TRANSFER PARAMETER TO DISPOSE
          JMP I     (5PDSP              % CALL DISPOSE

          )FILL
)9END

)9EOF
```

Open Forum For Members

Lawrence Berkeley Laboratory
University of California
Berkeley, California 94720
Telephone 415/486-4000
FTS: 451-4000

Pascal Users Group
c/o Rick Shaw
DEC
5775 Peachtree Dunwoody Road
Atlanta, GA 30342

Hi,

I understand that the Pascal Users Group is interested in putting together a package of software tools. We of the Software Tools Users Group are doing much the same thing. We have some 50-60 tools (editing, text manipulation, formatting, sorting, command line interpreter, etc.) which simulate the Unix environment and originated from the little book Software Tools by Brian Kernighan and P. J. Plauger. The tools are currently written in ratfor, a portable Fortran-preprocessor language, and running on everything from an 8080 to a Cray. Our users group has a mailing list of almost 700 and holds meetings twice a year.

There have been several people in the group interested in translating the tools into Pascal. One man has already hand-coded a few of them in Pascal. Another group in England has used a mechanical translator written in Snobol to transfer the tools into BCPL. I think a similar translator could be developed to translate into Pascal. If people in your group were interested in our tools, perhaps we could work together to build such a translator.

I've enclosed an LBL Programmers Manual to give you an idea of what we have available. Other sites also have nice tools--University of Arizona and Georgia Tech. have good packages too. I've also sent along our newsletters to give you an idea of what the users group is doing.

Even if translation of our tools into Pascal doesn't seem feasible, do let me know if you think there might be other ways our groups could work together.

Sincerely,

Debbie Scherrer

Debbie Scherrer
Co-ordinator, Software Tools
Users Group

the Time-Machine Ltd.
טיים-משין בע"מ

Dear Editor,

I am happy to have(at last) PUGN #15.
It arrived only in July, 1980, but better late than never. 2 Questions:

1) What happened to #14? I've never seen it.
2) How do I renew my membership for the next year (starting June-1980)? PUG #15 does not have any "all-purpose coupons". I am very interested in PUGN, just let me know how to pay for it.

Now,for the PASCAL issues. We use the FORMAT prgram published in PUGN #13, and all our sources have to pass it,so we achieve uniform layouts. There were several problems setting up FORMAT,some of them were real bugs. But now it is well and running with all the options operative. I must mention its portability. We moved it from RSX-11M to UNIX within half an hour,just by changing the file handling part.
We do almost all our development in PASCAL and have several utilities to offer to anyone interested:

1) File copying between CP/M and UCSD in both directions
2) File copying between RSX-11M and UNIX in both directions
3) The debugged FORMAT on RSX and on UNIX
4) File copying from an IBM diskette to UCSD
5) A big (CMD) disk driver for a Z80 under UCSD

By the way ,UCSD software seems very unportable,due to lots of non-standard tricks which are heavily used.

Best regards,

Gershon Shamay
Mgr. Software Development

Eder St. 49a, P.O.B. 72, Haifa, Israel. Phone: 04-246033.
Telex 46400 BXHA IL, For No. 8351

SDC INTEGRATED SERVICES, INC.

System
Development
Corporation

PASCAL USER'S GROUP
c/o Rick Shaw
Digital Equipment Corporation
5775 Peachtree Dunwoody Road
Atlanta, Georgia 30342

Dear Mr. Shaw:

I maintain PASCAL 6000 Version 2 and Version 3 at NASA, Langley Research Center, Hampton, Virginia. I have made several modifications to our compilers to enhance the usability of the compilers without changing the language itself. I am writing to describe briefly one such modification because it is easily implemented and may be useful to other installations. This modification introduces a new option to the compiler which displays the locations of the fields within a record when invoked. Following each record type declaration, the field identifiers with their relative locations in the record are given. The following is an example of the output generated by our compiler with the option invoked:

```
 3    REC = PACKED RECORD
 4          FIELD1: CHAR;
 5          FIELD2: CHAR;
 6          FIELD3: INTEGER;
 7          FIELD4: PACKED ARRAY[1..200] OF BOOLEAN;
 8          END;
------------------------------------------------------------------------
FIELD1      0:<59,54>                    FIELD2      0:< 5, 0>
FIELD3      1:<59, 0>                    FIELD4      2:<59,  > -  5:<  ,40>
------------------------------------------------------------------------
 9
10 VAR
11    VREC: RECORD
12          STORAGE1: INTEGER;
13          STORAGE2: CHAR;
14          STORAGE3: BOOLEAN;
15          STORAGE4: REAL;
16          END;
------------------------------------------------------------------------
STORAGE1    0:<59, 0>                    STORAGE2    1:< 5, 0>
STORAGE3    2:< 0, 0>                    STORAGE4    3:<59, 0>
------------------------------------------------------------------------
17
```

The formats used above have the following meanings:

W:<B1,B2>	Indicates the field is in word W relative to the start of the record and uses bits B1 through B2.
W1:<B1,>-W2:<,B2>	Indicates the field is longer than 1 word beginning at word W1, bit position B1 and going through word W2 bit position B2.

This type of information can be very helpful when interfacing with other languages such as COMPASS or FORTRAN and also when trying to minimize the size of a record by rearrangement of its fields.

Sincerely,

Ricky W. Butler
Systems Programming
SDC-Integrated Services, Inc.

for

NASA, Langley Research Center
Hampton, Virginia
MS 157B

RWB/ghf

P.S. To obtain more information or the update mods for this option contact:

Rudeen S. Smith
MS 125A
NASA/Langley Research Center
Hampton, Virginia 23665
(804) 827-2886

THE UNIVERSITY OF KANSAS LAWRENCE, KANSAS 66045

Department of Computer Science
114 Strong Hall
913 864-4482

Rick Shaw
Pascal User's Group
Digital Equipment Corporation
5775 Peachtree Dunwoody Road
Atlanta, Georgia 30342

Dear Rick:

Since the last time I wrote to PUGN (PUGN #11 - February 1978), many things have happened both here at KU and with Pascal on Honeywell/GCOS. I'll start off with the new happenings with Honeywell Pascal (under GCOS not MULTICS).

Pascal version 7 is available and is finally complete (up to now the PROGRAM statement was not recognized). This version has much better error messages and is very stable (at the moment there are only a very few known bugs and those are minor). It fully implements the Pascal described in Jensen and Wirth (except for file of file). There are two major extensions: and "else" clause in the case statement and the variant record, and a relaxation of the type checking when applied to variables and constants of "packed array of char" (the first elements of each are made to align and the shorter is logically blank extended for compares and assignments; strings can be read using read). Pascal is available through Honeywell marketing, but was written and is maintained at the University of Waterloo. Anyone interested in obtaining a copy of the documentation should write to: The Oread Bookstore / Kansas Union / The University of Kansas / Lawrence, Kansas 66045 and request a copy of "Pascal on the Honeywell Computer System" ($3.00 plus $1.00 postage).

I have been promoting Pascal in the Honeywell Large System Users Association (HLSUA). I am the chairman of the Scientific Language committee and have given 3 talks about Pascal over the last 2 years; one a tutorial about Pascal, and the other 2 comparisons of Pascal compile and run times versus FORTRAN, B and C (unfortunately Pascal came out on the short end most of the time). I will include a copy of the 'comparison' paper with this letter.

Pascal has been in use at the University of Kansas since 1976. Almost all the undergraduate computer science classes use Pascal. We teach a university wide service course which serves as an introduction to programming to over 900 students a semester. For the past two years some portion (at least 1/3) of these students were taught Pascal (the others were taught FORTRAN). This coming Fall semester, the Pascal portion will be slightly greater than a half. Myself, another graduate student, and a faculty member have put together a brochure which we are distributing to the faculty of other schools within the university who use our introductory class. The purpose of the brochure is to introduce the other faculty members to Pascal and to explain why we (CS) want to teach Pascal, instead of FORTRAN, in the introductory course. After sending the brochure, we meet with the faculty from the other department or school and answer any questions they want to ask and further expand upon the reasons for teaching Pascal outlined in the brochure. (Within the CS department, our little group is known as the "Pascal Road Show".) Thus far, we have only met with faculty from the School of Engineering. We have had some success. If they can find 1 more credit hour in the majors involved, they have tenatively agreed to allow their students to take Pascal as their first language if we also offer a 1 hour course for their students in which they would learn FORTRAN. We currently have plans to meet with the faculties of Business and Journalism next fall.

If any other schools have done this, I would very much appreciate hearing from you. If anyone is interested in our brochure or in talking about our experiences, I'd be happy to do whatever I can.

Other Pascal news from KU: we have a student oriented Pascal syntax checker (written in B using YACC - probably not portable except to another Honeywell). The syntax checker runs much faster than the compiler and generates much more explanative error messages. It explicitly looks for many of the mistakes commonly made by novice programmers and diagnoses them. There should be a paper written on this project (by Jim Hoch and Uwe Pleban) in the upcoming months. I have ported the Path Pascal compiler (written at the University of Illinois and acquired through Dr. Edwin Foudriat at NASA-Langly) to the Honeywell and am currently porting a newer version of the compiler (we have to change 112 out of 7562 lines in the source). We have almost all of the programs that have appeared in PUGN up and running, most of which required only minor changes. (The portability of Pascal and its availability on micro computers have been the most important arguments to others in convincing them of the value of Pascal, let's keep it standard!)

I'd like to thank everyone at PUG central (Andy, Rick, and all the others whom I don't know) for the great job you're doing. PUGN is a tremendous help in promoting Pascal and the standards efforts by PUG-USA and Tony Addyman with BSI are extremely important to the vitality Pascal currently enjoys. Again, thanks.

Sincerely,

Greg

Gregory F. Wetzel
Assistant Instructor

huntec
(70) LIMITED

25 HOWDEN ROAD,
SCARBOROUGH,
ONTARIO, CANADA
M1R 5A6
PHONE (416) 751-8055
TELEX 06-963640
CABLE HUNTOR, TORONTO

Dr. A. M. Addyman,
Dept. of Computer Science,
University of Manchester,
Oxford Road,
Manchester M13 9PL
England

Dear Dr. Addyman:

This is a comment on the proposed Pascal standard.

It is good to see that conformant array parameters are to be included in the Pascal standard in a neat and carefully considered manner. This will prevent the proliferation of non-standard implementations (an alarming thought).

I do wish to take issue with the proposal to exclude the "packed" attribute from the conformant array schema (Pascal News 17, p. 54). My reasoning is this.

1. A problem with Pascal perceived by a number of applications programmers is the difficulty of manipulating strings and of formatting text output (and interpreting printable input).

2. The logical response is to make available a library written in standard Pascal which will perform formatting and string manipulation. (Some can be found in Pascal News 17.)

3. If conformant packed arrays are not permitted, such a library must use standard length strings, longer than the longest actual string which is to be processed. Alternatively strings must be processed in unpacked arrays. In either case, there is a wastage of storage space, which is a significant problem for some users. Or, space can be allocated dynamically in chunks for strings. This complicates the library routines, resulting in a wastage of program storage, again a significant problem.

4. The problems cited by A.J. Sale which lead him to recommend against packed conformant arrays are really no more serious than the implementation of packed arrays themselves. When referencing any packed array, information on the bit-length of the component type is always needed. When the packed array is a conformant packed array of conformant packed arrays, the bit length will have to be passed by the calling procedure, rather than being a constant. Since the array dimensions already must be passed, this is hardly a serious problem!

5. More generally, packed arrays should be permitted to be used anywhere that unpacked arrays are permitted, unless there is a very powerful reason to forbid that use. One place where there is a real problem is in the use of a component of a packed array as a variable argument to a procedure. That is the only place where packed arrays arelimited, at present. If more limitations are introduced, the result, as Sale suggests, will be non-standard compilers which support conformant packed arrays. This will have a detrimental effect on portability.

My reasoning may appear highly dependent on the perceived need for easy string manipulation facilities. But articles too numerous to mention have been appearing on the topic of strings, and the reason is that this is a problem which is encountered by virtually every applications programmer. So please - let's not go halfway on the conformant array problem.

Thank you for considering my comments.

Yours truly,

Jack Dodds

Jack Dodds

cc A. J. Sale
J. Miner
Pascal News

Enertec inc. *19 JENKINS AVE., LANSDALE, PA. 19446*
Phone: (215) - 362-0966

Pascal Users' Group
c/o Rick Shaw
Digital Equipment Corporation
5775 Peachtree Dunwoody Road
Atlanta, Georgia 30342

Dear Rick:

This letter is to inform you and all PUG members of the introduction of a Pascal-based real-time applications programming language called Micro Concurrent Pascal (mCP). mCP was developed and has been used by ENERTEC over the past two years. ENERTEC is a small systems software house which uses and develops Pascal-based software tools for our programming needs.

Micro Concurrent Pascal was developed from Per Brinch Hansen's Concurrent Pascal; however mCP is a language in its own right. The mCP compiler is a stand-alone program and interpreter/kernels presently exist for the Z80 and 8080/8085 microprocessors.

Brinch Hansen's Concurrent Pascal extends Pascal with the real-time programming constructs called processes, monitors and classes. In addition to the process, monitor and class constructs, Micro Concurrent Pascal contains the device monitor construct.

A device monitor is a variant of a monitor which permits the writing of device drivers directly in mCP. Each device driver is associated with a specific interrupt. Processes call device monitors to do I/O. The DOIO statement, permissable only in a device monitor, blocks the process which called the device driver until the associated interrupt occurs. Other statements restricted to device monitors allow an mCP program to access absolute hardware addresses and perform bit manipulations on data. Among other ENERTEC additions are:

- a drop-to- assembly language capability
- separate data types for 8 and 16 bit integers
- string manipulation intrinsic routines
- hexadecimal constants

Additionally, P-code output by the Micro Concurrent Pascal compiler is approximately one third the size of the P-code output by Brinch Hansen's Concurrent Pascal compiler.

I've enclosed a technical article which walks through the programming of a simple real-time operating system in Micro Concurrent Pascal. Anyone interested in mCP is invited to call or write to ENERTEC.

Keep up the great work with Pascal!

Sincerely,

Cynthia Fulton

CF/cc
enc.

PASCAL USERS' GROUP

Gentlemen:

I am a deputy district attorney in a rural area at the foot of the Rocky Mountains. The Institute for Law and Research, Washington, D.C., has implemented a Prosecution Management Information System (PROMIS) in COBOL for Big Machines and for minicomputers.

I am interested in adapting at least part of that system to microcomputers, especially in view of the availability of 8" hard disc drives. Pascal may be the ideal language for it. Can any of your readers provide insights into the process of creating data base management systems with Pascal, and with practical, if not optimum, algorithms for using hard disc storage? I'm fluent in MBASIC and the CP/M systems, but Pascal is new to me. I would appreciate hearing from anyone interested in the PROMIS project, as well as anyone who can recommend books or articles for the study of Pascal. The Pascal available to me presently is the UCSD Pascal for microcomputers.

Finally, I would be interested in comments concerning the relative strengths and weaknesses of the Microcomputer COBOLs for data base management vis-a-vis Pascal (assuming a Pascal implementation which includes random disc files, and reasonable interactive facilities for on-line terminal I/O).

Thank you. I look forward to seeing my first copy of the newsletter.

Sincerely,

Dennis E. Faulk
911 Harrison Ave.
Canon City, CO 81212
(303) 275-1097

DataMed
RESEARCH

The Pascal User's Group, c/o Rick Shaw
Digital Equipment Corporation
5775 Peachtree Dunwoody Road
Atlanta, Georgia 30342

Dear Rick:

I am enclosing with this letter notices of two new projects of which I am very excited: the UCSD Pascal Users' Group and SOFTDOC, a medical software network featuring Pascal as the preferred language.

Fundamentally, the reason behind the UCSD users' group is that to date, it is the best Pascal system for microcomputers, trading somewhat slower execution for speedy disk access (three times faster than CP/M), a superb development and operating system, and compact code, allowing macro programs in mini memories. As we all recognize, because Pascal is so close to the machine, there is a great need to develop a library of commonly used routines so we don't have to continually "reinvent the wheel" each time we program. I and my friends have been using the UCSD system a great deal, and a fair amount of software is beginning to be exchanged -- enough to fill up two volumes. I have included the two Pascal formatters/prettyprinters published in the Pascal News No. 13, as well, and plan to enter the other superb Pascal software tools you publish as time permits.

We microcomputer users receive little benefit from software offered on 9-track tapes (I suspect the tape drive costs more than my entire system); so machine-readable software must be shared on floppy disks. Because UCSD has been so careful (almost paranoid) about preserving the integrity of their RT-11-like disk and directory format, it turns out that anyone running UCSD Pascal on a system with access to an 8-inch floppy drive can share software inexpensively, regardless of the host CPU.

I do have a question about software published in the Pascal News. Programs published in magazines or journals are generally considered to be in the public domain. Would the members of the Pascal User's Group have any objection to my offering, as inexpensively as possible, the software published in the Pascal News to anyone who can utilize an 8-inch floppy disk? Of course, the source will be acknowleged, and I am including sufficient documentation on the disk so that users need not refer elsewhere to be able to use the software. I have made the minimal changes necessary for the programs to run on a UCSD system. I would like specifically to inquire whether there is an objection to my making available the Validation Suite published in No. 16.

SOFTDOC is more ambitious than the users group project. Medical computing has been at an impasse almost since its inception: medically trained people tend not to use tools developed by nonmedical personnel, including programmers, because these tools rarely fit into the pecularities of medical thinking and practice. So there is a history of failure, and not a little bitterness on the part of computer professionals. Few accepted uses of computers in the health sciences exist outside of the laboratory.

As you can see in the enclosed material, the aim of SOFTDOC is to form a network of health care professionals, via a floppy-disk journal, so that together we can develop medical applications for computers that are truly valued by clinicians. I am informing the members of the PUG of SOFTDOC because UCSD Pascal is the preferred language for programs submitted to SOFTDOC for disk publication. In addition, I believe the enormous potential of Pascal for medical computing (exclusive of applications requiring sizeable mathematical power and speed) has been insufficiently emphasized.

I would be interested in hearing from anyone with further ideas on sharing microcomputer software inexpensively, especially in the area of medical computing. Let me know, too, if you would like to work out some sort of reciprocal sharing arrangement. Perhaps I would send the PUG a copy of each disk as it was released, and you would publish items of interest to the broader PUG.

Sincerely,

Jim

Jim Gagné, M.D.
President

SOFTDOC is a new service recently announced by Datamed Research to aid health professionals who are interested in utilizing computer systems in their practices.

Small computers have the potential to serve a myriad of needs in health care practices. Such applications as obtaining the routine portions of histories directly from patients, patient education, and limited assistance with diagnosis or treatment are readily achievable. To date, most authors of medical computer programs have not taken into account the true needs of health care professionals, and the programs have not been utilized by those they were designed to serve. Effective medical computing requires a network of health professionals writing programs and sharing their software.

In the past fifteen years, over a hundred health professional office business systems have reached the market. While the majority have failed, a few have transformed the business office into a streamlined, highly accurate system. Unfortunately for the small office, the cost of the better systems usually exceeds $30,000. Now, however, with the advent of quality hardware systems for well under $10,000, new, less expensive medical business packages are being released. The difficulty is to locate software of quality amid a rain of inadequate programs.

SOFTDOC will support the emergence of high-quality, low-cost medical computing in the following manner:

1) We are now issuing a call for health-related software to be published in a quarterly machine-readable software journal.

2) The journal will also contain in-depth user reviews of both SOFTDOC and commercial software, so that together we can determine just which programs are the most effective and why.

3) Datamed Research will collect and evaluate vendor's descriptions of commercial software. In addition, user evaluations of software will be collated and summarized. Our findings will be published semiannually in the SOFTDOC journal. Vendors and users who participate in the evaluation will also receive a summary of the findings. Because to date the focus of software products for health professionals has been the business office, our initial concentration will be in this area.

The preferred medium of SOFTDOC is IBM-compatible floppy disks; for the convenience of those without 8-inch floppy drives, it will also be issued in printed form. Material on a disk may be submitted to SOFTDOC for inclusion in the first issue until May 1, 1980; all programs must be in source code form and contain adequate documentation. Publication will take place on June 1, 1980, and quarterly thereafter. Subscriptions will cost $55 per year, or $18 per individual diskette. Those who donate software, reviews or articles will receive a one-issue credit per item published.

Subscribers must indicate which they prefer: 8-inch, single-density, single-sided, IBM-compatible floppy disk available in CP/M or UCSD Pascal format (specify) or hard copy. We would like to find someone who can copy the material on 5-1/2 inch diskettes for distribution in that format. However, these are not available at the present.

If you are interested in promoting valid medical uses for microcomputers, we invite you to send us programs you have written. Your software will be given the widest possible distribution. Together, we may change the long overdue promise of medical computing to a reality.

A New, Minimal-Cost Software Club for Users of UCSD Pascal

Introduction.

The UCSD Pascal language system is one of the most sophisticated microcomputer software systems available today. Because of the ease with which one can write and maintain high quality programs of most types, from systems software to business applications to games, it promises to be the vanguard of an enormous interest in Pascal in the coming decade. Already a number of other Pascal implementations have appeared for microprocessors, though none so complete.

UCSD Pascal compiles its programs to P-code, designed for a hypothetical 16-bit stack machine that must be emulated in software on most microprocessors. As a result, once the P-code interpreter has been installed, programs written in UCSD Pascal may be run on any microprocessor without modification. Even the disk formats are the same, except for the minifloppies used for the Apple, North Star, or TRS-80. So disk software in either source or object form may be freely shared among users of such diverse machines as a PDP-11 or an 8080.

The Pascal Users Group.

It would seem natural for a large users group to arise to share software. To date, however, only the original Pascal Users Group ("PUG") serves this function. Primarily, they support the standard language based on the Jensen and Wirth Pascal User Manual and Report and report on available Pascal implementations and programmer opportunities. Only secondarily does the PUG disseminate software (based on Jensen and Wirth Pascal), although since 1978 the PUG has published several superb "software tools". The major difficulty with the PUG newsletter is that it is offered only on paper; any machine-readable software is offered on 9-track tapes, which are not supported by the majority of microcomputers. So a microcomputer user must type the software into the machine on his/her own.

A UCSD Pascal Users Group on machine-readable media.

Datamed Research is announcing the formation of a UCSD Pascal users' group. It will take a form very similar to the highly respected CP/M Users Group: all offerings will be on 8-inch, single density, IBM-compatible soft-sectored floppies, offered virtually at cost ($10 per disk). Software will be donated by interested users. Software donors will receive a free disk volume of their choice in acknowledgement of their donation. For software to be accepted for distribution it MUST come with adequate documentation on the disk. Further, with rare exceptions it must be supplied in source code to allow other users to adapt it to their systems.

Potential sources of Pascal software abound; by no means must one donate only original work. There is a mountain of public-domain Basic software that is easily adapted to Pascal. In the process, one can usually spruce up the program a good deal, because Pascal is so much easier to work with than Basic. It will be important, in addition, for the users to begin a library of Pascal procedures and functions to handle the more common programming problems. For example, we need a set of mathematical functions for complex variables, statistical functions, and basic business software support (routines to translate integers into dollars and cents and vice versa) to realize the full power of the language.

You can find out more about the present status of the users group by sending a self-addressed, stamped envelope to the following address:

DATAMED RESEARCH
1433 Roscomare Road
Los Angeles, CA 90024

Alternatively, 8-inch floppies can be ordered at $10 per volume; there are two volumes available at the present time. Because the BIOS for the 512-byte sectors is written for Digital Research's CP/M-based macroassembler, the second volume contains both a CP/M- and a UCSD-format disk (though if you prefer, both disks can be of the same type; the volume is of use primarily to those who have both CP/M and the UCSD system, however) and costs $20. California residents must add 6% sales tax. Be sure to specify UCSD or CP/M format.

2103 Greenspring Dr. Timonium, Md. 21093 (301) 252-1454

Protection Systems SYGNETRON

24-June-1980

Pascal User's Group
c/o Rick Shaw
Digital Equipment Corp
5775 Peachtree Dunwoody Rd
Atlanta, GA 30342

Dear Rick:

Thanks for all your work to help keep the lines of communication open between all us Pascal user's. It's good to hear that all the moving and setup is now complete.

I am currently using Pascal in developing small real-time process control systems based around Z80 micros. At present I am using Pascal/Z running under CP/M and MP/M although I am also interested in finding more out about using a concurrent Pascal compiler for the same application. Also I use UCSD Pascal for other development on the side although I am disappointed at Pascal/Z incompatability with the UCSD Pascal. May the standard come soon.

I would very much like to hear from others in the Baltimore-Washington-Philadelphia area using Pascal/Z and/or doing real-time multi-task applications with Pascal in order to swap stories. Also would like to borrow if possible any of issues 1..8 of PN to look through or copy from someone close by.

Thank you.

Sincerely,

David McKibbin

David McKibbin
c/o Sygnetron
2103 Greenspring Drive
Timonium, MD 21093

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Pascal Standards

Pascal Standard: Progress Report

by Jim Miner (1980-07-01)

A serious disagreement over conformant array parameters is the only major remaining obstacle to obtaining an ISO standard. Hopefully both sides will quickly resolve this impasse in a friendly and diplomatic way, because there is a real possibility that one or more national groups will be compelled by time constraints to break with the international effort and seek to obtain their own standard.

RECENT EVENTS

Voting on DP 7185

The latest draft standard ("DP 7185") was published in Pascal News #18 and in SIGPLAN Notices (April 1980). Votes cast by specific national bodies on this draft are as follows.

Votes on DP 7185

Approval	Approval with comments	Disapproval
Finland	Australia **	Canada
Hungary	Czechoslovakia *	Germany
Italy	Denmark *	Japan
Romania *	France	U.S.A.
Sweden	Netherlands	
	U.K.	

* "Observer" member -- vote is advisory.
** Australia has become a "Principal" member since this vote.

Working Group 4 Meeting

The comments accompanying the votes revealed several technical inadequacies as well as some issues on which there is disagreement. Tony Addyman's report "The Pascal Standard: Progress and Problems" (below) discusses several of these issues.

The ISO Working Group on Pascal (WG4) met in Manchester England during June in an effort to resolve these issues and to prepare a second Draft Proposal. (See Pascal News #17, pages 83-84, regarding the origins of WG4.) Attendees were:

Tony Addyman (U.K.)
Burkhard Austermuehl (Germany)
Albrecht Biedl (Germany)
Coen Bron (Netherlands)
Joe Cointment (U.S.A.)
Christian Craff (France)
Jacques Farré (France)
Charles Haynes (U.S.A.)
Ruth Higgins (U.S.A.)
Mike Istinger (Germany)
Pierre Maurice (France)
Jim Miner (U.S.A.)
Kohei Noshita (Japan)
Bill Price (U.S.A.)
Helmut Sandmayr (Switzerland)
Karl-Heinz Sarges (Germany)
Barry Smith (U.S.A.)
Alain Tisserant (France)
David Williams (Canada)

JPC Meeting

A few days after the Manchester meeting, the U.S.A. committee (JPC) met in Portland Oregon. Out of that meeting came the memos from David Jones to WG4 and to the National Bureau of Standards which are reproduced below.

THE PROBLEM

As Tony's article points out, the most difficult problem which the standard now faces is the disagreement over "conformant array parameters". It has been clear to many of us who are deeply involved in the standardization work for some time that this topic could give us much trouble. The extent of the present difficulty became more obvious at the Working Group 4 meeting in June. No conclusion was reached by WG4 regarding conformant array parameters.

The papers by Tony Addyman and David Jones, together with Arthur Sale's article in Pascal News #17 (pages 54-56), provide much insight into the nature of the disagreement.

In favor of conformant arrays

The capability to allow formal array parameters to have "adjustable" index ranges is deemed necessary for the construction of libraries of separately compiled procedures, especially numerical routines. It is argued that failure to standardize now on the form of such a capability will make future standardization impractical due to many incompatible extensions which will be made to provide the capability.

Based on statements made in the WG4 meeting, the following member bodies are likely to vote "No" on a Draft Proposal which does not contain a conformant array feature: Germany, Netherlands, U.K.

Against conformant arrays

Those opposing the inclusion of conformant arrays in the standard argue that the proposal is technically flawed and as a result that its inclusion in the draft will delay the entire standard. (The attachment to David Jones' memo to Working Group 4 contains a technical assessment of the existing proposal.) It is also argued that conformant arrays are not needed more than other extensions which have not been included in the draft proposal.

Based on statements made in the WG4 meeting, member bodies likely to vote "No" if conformant arrays remain are Canada, Japan, U.S.A.

Variations on the theme

Some member bodies have expressed a preference for generalizations of the conformant array feature; Germany, for example, voted "No" partly because value and packed conformant arrays are not allowed.

The U.S.A., which has expressed opposition to conformant arrays on several occasions, proposed a compromise in its vote. The compromise would make conformant arrays optional for an implementation, but with the requirement that any such capability supported by an implementation have the syntax and semantics specified in the standard. Several members of WG4 expressed dislike of this proposal.

CONCLUSION

The standard has been stalled by the disagreement over conformant array parameters. In order to obtain an ISO standard, it is necessary that a compromise of some kind be reached. At this time it is hard to predict what the nature of that compromise will be.

The Pascal Standard : Progress and Problems, May, 1980

A. M. Addyman

University of Manchester

1. Introduction

Within the International Standards Organization (ISO), there is a work item which is to result in the production of a standard for the programming language Pascal. This work began in ISO in October 1978 as the result of a proposal from the United Kingdom. Work in the United Kingdom began early in 1977. At the time of writing this report, a ballot is taking place within ISO on the acceptability of the first Draft Proposal for the Pascal standard. This report, written immediately after the April 1980 meeting of the U.S. Joint Pascal Committee (X3J9), contains a summary of the substantial progress made to date and discusses the few remaining problems which stand in the way of international agreement.

2. Progress

There is now agreement on the details of all the main areas, although in one or two areas the wording is being improved or drafting errors are being corrected. The areas in which agreement has been reached include:

lexical issues,
scope rules,
type rules,
the syntax and semantics of the statements and declarations,
almost all of the input and output facilities.

Indeed, since there is agreement on so much, it would be better to devote space to the consideration of those issues which have yet to be resolved. Before doing so it should be noted that there is agreement that a standard is needed without delay. This attitude has helped to resolve minor differences of view, since neither party has wanted to risk the standard on such issues.

3. Problems

The outstanding problems will be divided into two categories - minor and major. The major problems are the ones which could substantially delay the production of the standard. The category into which a problem has been placed is necessarily a matter of personal judgement.

3.1 Minor Problems

3.1.1 Alternative Lexical Tokens

The issue is simply that (.and.) should be accepted as alternatives for [and] . There are strong feelings both for and against this. The strongest opposition appears to be from the U.K. The probably outcome will be acceptance of the alternative tokens.

3.1.2 String Truncation on writing

This is a request which involves a change from the current de facto definition. Its advocates cite efficiency, utility and frequent violation of the de facto definition as justification for the change. Opponents argue that

(a) this is a change and consequently must be rejected, and

(b) that a truncated representation of the array cannot in any way represent the array.

The possible outcome is unclear, but will undoubtedly be influenced by the U.S.A. position on the major problem (see later).

3.1.3 Tag-fields

There are three loosely related problems in this area:

(a) a change to prohibit use of tag-fields as var-parameters

(b) a relaxation of the syntax to replace "type" by "type-identifier"

(c) a change which would disallow the creation of tag-less variants

Each of these is a change to the de facto definition and as such provoke opposition.

The first is proposed in the interests of promoting the implementation of certain checks desired by the Draft Proposal. It will probably be accepted.

The second change is a change to the syntax to eliminate one of the circumstances in which a type-identifier is necessary and a type definition is unacceptable. The change was strongly opposed at the Pascal Experts meeting in Turin. I expect this opposition to continue..

The third change is proposed on the grounds that its only uses are in implementation dependent "dirty tricks". While this is untrue, the wording of the Draft Proposal suggests that an implementation which performs checks in this area will have to provide a tag-field if the programmer does not. The only justification for this feature which is within the proposed standard is associated with the saving of storage space for variables. Since a large number of implementations incorporate this restriction, which is aimed at improving security, there is a possibility that it will be accepted.

3.1.4 New and Dispose

There is a form of these standard procedures which may be used to reduce the storage requirements of a program. The use of this feature may lead to errors which are difficult for the programmer to detect, furthermore an implementation can detect such errors only by using additional storage! There is pressure to have this form of new and dispose removed.

Given the increasing usage of Pascal on microcomputers it is likely that the definition of new will be unchanged. There is a much stronger case for changing dispose since most implementations maintain enough information to ensure the security of the heap. The final irony is that the Draft Proposal identifies two error conditions which can only be detected by maintaining enough information to make this form of dispose redundant.

3.1.5 The Rest

There are a number of minor problems which have been raised by various parties and subsequently dropped e.g. the U.K. Pascal group has expressed a desire to remove pack, unpack and page from the language; other European groups have requested extensions to the case-statement and changes to the syntax of a block etc. There is a danger that decisions to make changes in any of the areas cited above may provoke more requests.

3.2 The Major Problem

3.2.1 Introduction

There appears to be only one substantial problem which may prevent agreement being reached on a Pascal standard. This is the problem of adjustable array parameters.

In the de facto definition of Pascal, a parameter of a procedure must have a specific type which in the case of an array will include a specification of the bounds of the array. This is viewed by many people as an unacceptable restriction in a language that is being proposed for international standardisation. As a result of the comments received on the document ISO/TC97/SC5 N462, the U.K. Pascal group resolved to introduce into the draft a minimal facility which would address the problem. The U.K. solution provided for var-parameters but not value parameters and also excluded packed arrays. The proposal from the U.K. has received objections on two counts:

(a) it is a change to the language - in particular, more work should be done on the details of such a feature before it is added to the language.

(b) the feature is too restrictive - value parameters and/or packed arrays should also be allowed.

To clarify matters the arguments which support the three positions will be presented separately.

3.2.2 In favour of the Draft Proposal

1. There is great demand for the feature to be added to the language, and those making the demands have not specified any particular syntax or semantics. Those supporting the addition include Prof. Hoare and Prof. Wirth.

2. In the interests of portability the feature should be required in any implementation of a Pascal processor.

3. There are no technical difficulties with implementing the feature in the Draft Proposal since all the "run-time" operations that are required already exist.

4. Requiring value adjustable array parameters has an impact on the procedure calling mechanism - the amount of space required by a procedure cannot always be determined at compile-time. There is concern that there may be existing implementations which rely on such a determination at compile-time and which would therefore be destroyed by the introduction of value adjustable array parameters.

5. Requiring packed adjustable array parameters places increased overheads on an implementation which packs multidimensional arrays. Such overheads may result in a reduction in the extent to which a packing request is heeded.

6. If action is not taken at this time a number of vendors will surely introduce incompatible extensions to fulfill this obvious need. Such action would effectively prevent future standardisation of this feature.

7. Of all the requests for extensions received during the comment period on ISO/TC97/SC5 N462, this is the only one which adds to the functionality of the language. All the other requests addressed issues of convenience and/or efficiency.

3.2.3 In favour of a less restrictive proposal

1. All the above arguments are accepted apart from 4 and 5.

2. Those in favour of value adjustable array parameters claim that no existing implementations will be embarassed and claim (correctly) that there are no technical problems.

3. Those in favour of packing fall into two distinct groups:

(a) those who believe that there are no implementation problems and that in the interests of generality the restriction should be removed.

(b) those who wish to use string constants as actual parameters. They appear to need both value (since a constant is not permitted as an actual var-parameter) and packed (since the Draft Proposal specifies that string constants are of a packed type). An alternative solution to this problem is to change the specification so that the type of string constant is context dependent (as is the case for set-constructors) in which case a string constant could also be a constant of an unpacked type. The same proposal also requires that those operators which apply to packed character arrays also apply to unpacked character arrays. This has the considerable merit of removing the only case in which the prefix "packed" is used for reasons other than storage reduction.

3.2.4 In favour of the feature being optional

This is a view expressed by the U.S.A. Pascal committee (X3J9).

1. A language designer must not add to a language any feature that is not very well understood, that has not been implemented, or that has not been used in real programs. The proposed adjustable array parameter feature is just such a feature. This feature should be widely implemented and used before it is incorporated into a standard for Pascal.

2. By placing the proposal in an appendix entitled "Recommended Extension" we derive the benefit of having the opportunity to implement the feature before casting it in concrete.

3. Implementors who add a feature which performs this function are required to comply with the recommended extension. This will make compatability with any future extended Pascal more likely without foregoing the possibility of learning more about the feature in the interim.

3.2.5 The Probable Outcome

There is considerable pressure from several ISO member bodies (the U.K. excepted) to remove the restrictions which the Draft Proposal incorporates relating to adjustable array parameters. The probable conclusion will be to permit value but prohibit packed and at the same time introduce the changes described above relating to the operations etc. available for character arrays. Unfortunately the proposal from the U.S.A. for removal of the feature to an appendix is likely to be opposed strongly by one or more member bodies. This view is based on the comments received from other ISO member bodies since the April X3J9 meeting. The strength of support for removal of the restrictions is unlikely to be compatible everywhere with a willingness to accept less than is contained in the Draft Proposal. One possible solution would be for X3J9 to accept the feature as part of the language. At this stage this does not seem likely since the X3J9 position was taken for largely non-technical reasons. This observation is justified as follows:

1. X3J9 is requesting changes to the existing de facto definition while objecting to this extension.

2. X3J9 is currently soliciting extension proposals - it is unlikely that any such proposals will be acceptable by their criteria in 3.2.4. 1 above.

3. To promote portability and improve the probability of agreement in a future standard, the extension must be implemented as specified in the appendix. An implementor may only experiment with an alternative if the recommended extension is also implemented. This adds no new freedom to the implementor since language extensions are not prohibited by the Draft Proposal!

4. X3J9 also supports the removal of some of the restrictions mentioned earlier.

3.3 Conclusions

The meeting of ISO/TC97/SC5/WG4(Pascal) to be held in June 1980 will be a crucial one. There is pressure within the United States to move on to consideration of extensions - this is being delayed by the current activities. In the United Kingdom there is a government funded project to create a validating mechanism for Pascal. This clearly needs a standard to validate against. Significant progress is required on this project by April 1981!

A negative vote by any member body on the second Draft Proposal, later this year, will probably terminate the international standardisation effort because it will introduce delays which are unacceptable to one or more member bodies who will have little alternative but to produce national standards instead.

There is a real danger that one of more ISO member bodies will find the removal of adjustable array parameters to an appendix as unacceptable as the United States finds their inclusion in the body of the standard.

27 June 1980

MEMO

To: ISO/TC97/SC5/WG4
Re: U. S. concerns on Pascal Standardization With Respect to the
Conformant-array Extensions

The Joint X3J9/IEEE Pascal Standards Committee has resolved to express its concern that the issue of conformant array parameters may significantly delay the acceptance of the draft proposed standard for Pascal as an international standard. The committee is anxious to explore any option which will lead to a solution of the conflict over this issue acceptable to all member bodies of SC5.

As you know, the US member body of ISO TC97/SC 5 voted against the acceptance of the first draft proposal, on the grounds that the conformant array feature should be described in an appendix to the standard. This position was a compromise offered in the hope that it would be acceptable to the other member bodies of SC 5 and thereby an international consensus could be quickly achieved. The position did not, in fact, reflect the true sentiment of the JPC, as expressed in a number of formal and informal votes, which was that a conformant array feature should not be included in the current standard for Pascal. In the beginning there was no proposal available to evaluate technically, and the committee's view was based on strategic considerations. These were that the introduction of a new and largely untried feature at such a late date would introduce technical problems which could not be resolved in time to avoid delaying the acceptance of the standard. This has in fact turned out to be the case, since the first proposal for a conformant array feature was sufficiently technically flawed to justify its replacement by a quite different proposal. There are still major technical objections to the latter so that the view of the JPC on conformant arrays remains unchanged, although it is now based on technical considerations. These are described in the attachment (which was accepted unanimously).

U. S. concerns on Pascal Standardization

This committee understands and shares the view that the conformant array feature attempts to solve a significant technical deficiency in Pascal. However, it feels that the technical objections should be resolved before such a feature is included in an International or American National Standard. The committee believes that this leaves two possible courses of action if a failure to agree on an International standard is to be avoided. The first is that a major international effort through the Working Group must be mounted to prepare a technically sound proposal. The committee believes that this is likely to require yet another complete revision of the proposed feature. Sufficient time must be made available for such work to be completed and properly evaluated. The second approach is that we should proceed as quickly as possible to standardize the language at a level at which it has been widely used for a number of years.

It is clear that the second offers the quickest route to a standard and we strongly recommend that it be adopted. However, we further recommend that the effort identified in the first approach be simultaneously initiated and that an acceptable conformant array proposal should be defined and included in a subsequent standard for Pascal as soon as possible.

Yours sincerely,

D. T. Jones
International Representative
Joint ANSI/X3J9 - IEEE Pascal Committee

Enclosure

Attachment: Conformant Array Ad hoc Task Group Final Report
U.S. Objections to Conformant Array Extension

1.0 Overview and general problems

The U.S. Joint Pascal Committee (X3J9) created an ad hoc task group to investigate the conformant array extension appearing in JPC/80-161 (Working draft/6) (6.6.3.1). This report together with JPC international liaison David Jones´ cover letter to the international working group (WG4) is the result of the task group´s investigation. Contributing members of the task group included Bob Dietrich, Hellmut Golde, Steve Hiebert, Ruth Higgins, Al Hoffman ,Leslie Klein, Bob Lange, Jim Miner, Bill Price, Sam Roberts, Tom Rudkin, Larry Weber (chairperson), and Tom Wilcox.

1.1 Lack of implementation experience

The current proposal has no widely known implementations. Various portions of the extension have been implemented in different compilers, but the group of features proposed here have never been combined together, except on paper. Furthermore, the implementations of the various parts of the extension have not (of course!) been in the context of the proposed standard. Since this is a new feature to the language, the introduction of this extension in the standard document is especially distressing.

1.2 Large change to text of standard

The conformant-array extension requires a large amount of text in the standard in order to describe it. Moreover, it requires modifications to sections outside of section 6.6.3 on parameters. In other words, the extension interacts -- at least in its description -- with many other parts of the language. For example, in section 6.7.1 the alternative "bound-identifier" has to be added

This means that the extension is major, with wide impact on the language. This is especially unfortunate in view of the fact that it only provides a single capability -- that of array parameters with adjustable bounds. A broader capability, might not require a significantly larger description.

1.3 Conformant-array concept not defined

It is of the essence of the Pascal language, and its principal distinguishing characteristic, that it is "based on certain fundamental concepts clearly and naturally reflected by the language" (page 1, section 0, forward to the Draft ISO/DP 7185). It is difficult, at best, to identify a fundamental concept that this extension is to support. The best approximation yet suggested is the adjustability of the bounds of a scalar-type used as the index-type of an array-type under certain circumstances of parameter usage. Inasmuch as this concept is founded on at least five identifiable concepts, it is difficult to see how it may be considered fundamental.

This absence of fundamental underlying abstraction is foreign to the nature of the language. This absence leads inexorably to user confusion and to language-designer confusion. The user is not provided a concept on which to base his understanding; the designer, likewise, is given no guidance in his language design. Since user experience is lacking, no evidence exists from which to draw any conclusions with respect to the lack of user understandability. However, the lack of guidance to the language designer is quite nicely evident from the volume of technical objection: the most acute examples are the dilemmas of packing and of value-parameters.

2.0 Problems with existing proposal

2.1 Set of types that may have to conform is unrestricted

The conformant-array extension provides no way to identify, at the point of declaration, the array types that may have to conform to some conformant-array parameter. Consequently, an implementation must ensure, a priori, that ALL array types can be handled correctly by the implementation of the conformant-array parameter extension. Hence, a user may have to endure severe implementation inefficiencies even though he does not use the conformant-array parameter extension. For example, an implementation of packed conformant-array parameters (an almost irresistible evolution of the present extension) may make many of the possible forms of data packing totally impractical. A solution that is integrated with the type naming mechanism would alleviate this problem.

2.2 Structural Compatibility

One of the fundamental clarifying decisions made in developing the draft standard from Jensen and Wirth was the rejection of so-called "structural type-compatibility" in favor of the more natural "name compatibility" (or a variation thereon). Such decisions have had a profound effect on the resulting language; it is important that such principles be applied consistently throughout the language.

Unfortunately, two areas of the existing (Jensen and Wirth) language resisted consistent application of "name compatibility": set-types and string-types. Both of these problems are directly attributable to the existence of inadequately typed value designators (i.e., character-string constants and set-constructors). It was deemed necessary to violate "name compatibility" in these two cases in order to avoid introducing new (and incompatible) language features.

The conformant-array extensions introduced in N510 and in DP 7185 both violate the underlying principle of "name-compatibility"; we have seen no attempt to justify this violation. This is inexcusable in the absence of problems of upward-compatibility, very simply because conformant-arrays are an extension.

One practical effect of this unnatural regression to stuctural-compatibility, as discussed elsewhere in more detail, is the difficulty encountered in extending the conformant-array capability to allow multi-dimensional packed arrays.

2.3 Parameter List Congruency

In the comments from the French member body (p.3, 6.6.3.6), they note that "the parameter lists (x,y:t) and (x:t, y:t) seem to be not congruent" and that this is the only part of the language where these two notations are not entirely equivalent. It is a correct observation that these are not congruent. However, given the current form of the conformant-array proposal, this surprising and aesthetically unpleasant inconsistency is absolutely necessary. If the two parameter list forms were congruent (as in N510), then the following example would be a legal program fragment:

```
type t = integer;
proc p1(var f1,f2: array[i..j: t] of u);
   begin f1:= f2 end; {end - p1}

proc p2 (proc fp(var f1: array[i1..j1:t] of u;
                 var f2: array[i2..j2:t] of u));
   var a: array[1..2] of u;
       b: array[1..3] of u;

   begin fp(a,b) end; {end - p2}

begin p2(p1) end;
```

It is impossible to know at compile time that the assignment (f1:= f2) is an error. To remove the necessity of this run-time check, a seemingly unrelated aspect of the language had to be altered. The alteration has been recognized as undesirable and the reason for it was certainly not obvious. It took some time to detect the effect of conformant-array-schemas on parameter-list congruency. In addition, there may be other apparently unrelated aspects that, as yet, have not been discovered.

2.4 Need to name a conformant array schema

There is no construct to allow the use of an identifier to denote a conformant array schema:

```
TYPE varray = array[i..j: integer] of integer;
  :
  :
PROCEDURE p(var param: varray);
```

The lack of this construct makes the proposed conformant array schema weaker, due to considerations of consistency and user convenience.

Before proceeding, it must be noted that the naming construct above must be accompanied some means of distinguishing the array bounds "[i..j]" for each individual usage. it is not clear that the currently proposed conformant array extension allows such a capability: this is a general problem in itself as well as a limitation on extensability (see section 3.5).

The first objection to the proposed conformant array extension is the bulkiness of the construct. The parameter list of a procedure or function is frequently placed on one line. The use of a conformant array schema makes this virtually impossible when more than one parameter exists. This and the added user cost of retyping the schema become significant when the same schema is used over and over again, as, say, in a library of mathematical routines.

When one conformant array uses another, in the following manner, the lack of an identifier becomes a clear oversight in the language:

```
procedure p(var a: array[lowa..higha: atype]
                   of arecord;
                var b,c: array[xlow..xhigh: integer;
                               clow..chigh: color] of
                       array [lowa2..higha2: atype]
                          of arecord);
```

Here it is desireable that the type of "a" in the type of the components of "b" and "c" to be the same.

The unfortunate consequence of adding the inadequately conceived conformant array schema to Pascal is a reduction in the prime desirabilities of convenience of usage and clarity of the printed program.

The lack of an identifier construct for conformant array schemas results in user, language, and implementation inconsistencies. Except for procedure and function parameters, the conformant array schema is the only construct in the parameter list that is not a single word. To new students of the language, it will always appear inconsistent. And, since the parsing of conformant array schemas is so different from other parameter-type-identifiers, it becomes an exception case, resulting in added complexity in the compiler.

The proposed conformant array schema is also shortsighted in that it does not permit the use of a conformant array schema as a part of a record, to be passed as a parameter. For example, many programs make use of dynamic "strings" implemented as records, i.e.

```
     type string = record
                      length: 0..80;
                      chars: array[1..80] of char
                   end;
```

for a dynamic "string" of maximum length 80. Supposing it were necessary to write a string-handling routine to handle records with differing maximum lengths, one could, with the help of a schema label, construct the following:

```
   type natural = 1..maxint;
        dynamicarray = array[i..j: natural] of char;
        string = record
                    length: integer;
                    chars: dynamicarray
                 end;
     :
     :
   procedure concat (var a,b,c: string );
```

This concise construct is absolutely unimplementable under the current proposal. On the other hand, the above type of construct could lead to some interesting extensions (not that they should be dealt with here).

Finally, note that making a change to a conformant array schema, used all over a program, is much more involved than changing the definition of a single conformant array schema identifier.

2.4 Separator ";"

The abbreviated form for contained conformant-array-schemata introduces the character ";" as an abbreviation for the sequence "]" "of" "array" "[" (6.6.3.1), thus allowing the form

```
          array[u..v:T1;  j..k:T2] of T3
```

to be equivalent to

```
          array[u..v:T1] of array[j..k:T2] of T3 .
```

This conflicts with the use of the character "," to express a similar equivalence for array types (6.4.3.2), where

```
         array [T4, T5] of T6
```

is equivalent to

```
         array [T4] of array [T5] of T6
```

One might therefore argue that for uniformity and possibly as an aid in compiler error recovery, the character "," should be used in the conformant-array extension.

However, there is unresolved disagreement as to whether the separator should be a comma or a semicolon. The existence of this disagreement demonstrates that the nature of the object to be separated is not well understood nor well specified.

2.5 Required Runtime checking of types

The proposed scheme specifies that the type of the formal parameter is the same as the type of the actual parameter. This presents serious difficulties when a conformant parameter is further used as an actual parameter, as illustrated in the following example.

```
  program example;
    type arraytype = array[1..10] of integer;
    var
      a : arraytype;
      b : array[1..10] of integer;
      c : array[1..11] of integer;
    procedure simplearray (var a:arraytype);
      begin end;
    procedure fancyarray(var a:array[m..n:integer]
                                of integer);
      begin
         simplearry(a)
    end;
    begin       {main program}
      fancyarray(a);     {legal}
      fancyarray(b);     {illegal - name incompatible}
      fancyarray(c);     {illegal- structure incompatible}
    end.
```

Another illustration of runtime type checking is shown in the following example.

```
  type
    natural = 0..maxint;
  procedure pl(var b:array[i..j:natural] of u);
    begin   end;
  procedure p2(var a:array[i..j:integer] of u);
  begin pl(a) end;
```

In this example, the passing of the variable "a" to "pl" may or may not be valid, depending on the actual parameter passed to "p2"

This problem is not addressed by the UK Member Body comments on DP 7815.

3.0 Limitations of existing proposal

The following items are brief descriptions of features that could someday be considered as possible extensions to the language. An evaluation and rationale for their desirability has not been completed at this time. The process of including these is impacted by the current definition of the conformant array extension. It is felt that unifying fundamental abstractions must be developed to cover the total set of any newly defined features.

3.1 Leading index types

Only leading index types of conformant-array-schemata are adjustable. Thus,

```
        array[j..k:Tl] of array[T2] of T3
```

is acceptable, while

```
        array[T2] of array[j..k:Tl] of T3
```

is not (6.6.3.1). This introduces an asymmetry into the definition. While a relaxation of this restriction does not offer any additional functionality, it would allow a more natural expression of certain relationships between index types.

3.2 The lack of packing

The conformant-array extension, as defined in Working Draft/6, restricts the allowable actual parameters to arrays not having the attribute "packed". This restriction eliminates the direct use of conformant arrays for string handling under the current limitation that the only arrays of char-type that may be compared, written to files or declared as constants are those arrays having the attribute "packed". This particular problem could be corrected by removing the "packed" restriction on string type although care would still be required on the part of the programmer to use only arrays with lower bounds of one and run-time checks would be required to ensure this care had been taken. Even if this string-type problem were resolved, the lack of orthogonality contradicts the Jensen-Wirth Report in which the obvious intent is that packed and unpacked arrays be generally equivalent except for the possible differences in storage requirements.

3.3 Value conformant-arrays

Introduction of a value parameter as part of the conformant-array extension is a natural addition, and there seem to be good reasons to consider this aspect of the conformant-array parameter. However, if this feature were to be added to the extension, then this is the first instance of a case where the size of the activation record is not known during compilation. The unknown size of the activation record causes a problem in an implementation that relies on knowing the activation record size in order to handle activation stack overflow. This is not to say that efficient implementations are impossible, but the two situations must be treated efficiently by compilers.

3.4 Conformant-arrays and bounds limitations

The conformant-array extension is not sufficiently general nor extensible: it does not provide the ability to fix either the lower or upper bound of a given index specification. Nor does it allow the user to equate the extent of one index specification with the extent of another, be it within the same conformant-array parameter or a different conformant-array parameter. This deficiency results in increased time and space complexity and hinders compiler optimization. Moreover, it requires an author to either validate one or more conditions cr trust the caller. The former introduces further deterioration of efficiency while the latter is inconsistent with the strongly-typed nature of Pascal. In addition, this lack in the conformant-array extension is in conflict with one of its primary uses: the construction of independent array manipulation routines. For example, possible uses of conformant-array parameters include general matrix multiplication and inversion routines where one would like to place restrictions on the bounds and interrelationship between index types of the actual parameters.

3.5 Conformant scalar-types

The conformant-array extension addresses only the role of a scalar-type as an index-type of an array-type parameter. It ignores the many other roles where it is desirable to conform a scalar-type parameter. A few such roles where such conformance might be desirable are:

1. as the type of a parameter;

2. as the base type of a set;

3. as the component type of an array;

4. as the type of a field;

5. as the index-type of an array used as the type of a field.

TO: National Bureau of Standards

FROM: David Jones
X3J9 International Liaison

SUBJECT: Report by A.M. Addyman

The Joint ANSI/X3J9 - IEEE Pascal Standards Committee (JPC) has received a copy of a report, "The Pascal Standard : Progress and Problems," written by A.M. Addyman of the University of Manchester. This report, hereafter referred to as JPC/80-164, presents an interpretation of the current impasse in the Pascal standardization effort with which JPC does not agree. I have been charged, as the JPC International Liaison, to present the committee´s point of view.

The primary issue over which Mr. Addyman and the committee disagree is discussed in sections 3.2.5 and 3.3 of JPC/80-164, although JPC takes issue with remarks in other sections. Before addressing the comments specifically, however, I shall present a summary of JPC´s point of view.

The true sentiment of the committee is that a conformant array parameter feature should not be included in the version of Pascal being standardized through the current effort. This view has been repeatedly documented, by both formal and informal resolutions passed either unanimously or by large majorities, beginning with the first time JPC became aware that the BSI group was considering the introduction of this feature. Initially, the opposition was based on strategic grounds (i.e., there was no proposal to formally evaluate). These were that the delay introduced by requiring a technical evaluation prior to acceptance of the feature would substantially postpone the adoption of a standard. The JPC does believe that the conformant array extension attempts to solve a real problem that will have to be eventually solved, and that finding such a solution is a matter of urgency.

The pessimism of JPC was justified in that the initial proposal offered by BSI was so flawed that it was withdrawn and replaced by an entirely new proposal at the Experts Group Meeting in Turin in November 1979. It is the position of JPC that this second proposal still contains technical errors and deficiencies sufficiently grave that yet another complete revision of the proposal will probably be required before an acceptable solution to the problem is found. Consequently, the strategic objections remain, but are now substantiated by technical considerations.

Nevertheless, when the committee voted in April, 1980 to recommend that the U.S. position should be to disapprove the draft proposal identifying conformant array parameters as being the only issue, it only required that this feature be removed to an appendix so that its implementation could be made optional. This represented a major compromise which, from the JPC point of view, was far from the real sentiment requiring that the feature be removed entirely from the proposal.

JPC is convinced that it is in the best interests of the Pascal User Community that any revision or extension to the language be supported by sound technical grounds, and that it is better to take the time to do it correctly or to accept a standard without conformant array parameters than to accept a technically inadequate proposal merely because it is timely to do so.

As far as the actual comments in JPC/80-164 are concerned, the remark in section 3.3.2 on support by Professors Hoare and Wirth should be qualified by the results of the discussions members of JPC had with them before and during the April meeting, of which Mr. Addyman was aware. Both indicated that the U. S. compromise was preferable to delaying the standard, and Professor Hoare himself was the source of this method of introducing this extension. The substitution of the word "standardizer" for "designer" in 3.2.4, paragraph 1, line 1, would accurately reflect the U. S. position. Without the substitution, it does not. Thus 3.2.5, paragraph 2, is also misleading. The use of the term "(correctly)" in 3.2.3, paragraph 2, is difficult to substantiate. The JPC is particularly at odds with the position that non-technical reasons were the justification for its disapproval. We cannot assume Mr. Addyman is referring to our strategic reasons because these reasons have a technical basis. Even in the beginning, the basic issues were technical although they could not yet be identified. Consequently, Mr. Addyman´s remark must be construed as implying a political basis for the JPC´s position. This is certainly not the case and we disagree with Mr. Addyman´s justification for his point of view as expressed in 3.2.5, paragraphs numbered 1 to 4. The following numbered paragraphs discuss our corresponding disagreement:

1. There have been many changes to the de facto definition of Pascal which have not been regarded as extensions and have been the subject of wide implementation and use. This does not apply to the feature in question, reflecting consistency in JPC´s position in this regard.

2. It is a subjective opinion that the criteria of 3.2.4, item 1, would preclude other extensions. It is stated quite clearly within the proposed standard that implementation dependent features are allowed, and that by implication a user is free to provide one or more versions of any given feature. By this means, an extension could become widely implemented before acceptance in a standard. In particular, an Appendix could be created for such a feature for the reasons in 3.2.4, paragraph 2, of JPC/80-164.

3. The JPC would prefer that the conformant-array extension be removed entirely from this standard for technical reasons. However, we recognized the claims of the other member bodies that they require this capability in the language. Therefore, the JPC proposed that the extension be in an appendix to address our concerns and we proposed that if the extension were implemented, it was to be implemented in the format specified to encourage acceptance by the other member countries. Since it is our preference to remove the extension entirely, it would be consistent with our position to soften the wording from a requirement to a recommendation.

4. JPC does indeed support the removal of these restrictions, but feels that the technical issues raised by doing so would introduce an unjustifiable delay into the standardization process.

Addressing section 3.3, it is the view of JPC that the position taken by Mr. Addyman (i.e., a negative vote would terminate the standardization process) is unduly pessimistic. In addition, this statement represents unwarranted pressure on the U.S. and the other two countries which voted against the conformant array extension due to significant technical deficiencies.

Implementation Notes

Editor's comments

Well, it was bound to happen. My section of issue #17 got scrambled. The right half of page 88 shouldn't have appeared at all, the Zilog Z-80 reports became recursive, and the machine-dependent section was all out of sequence. My sincerest apologies go to Arthur Sale, whose letter on the Burroughs B6700/7700 implementation was dropped completely, and to my co-editor Greg Marshall, whose hard work on the One-Purpose Coupon went without credit. Things should be straightened out with this issue (I hope).

Just to add to the overall confusion, I've changed my address and phone number within Tektronix. This move is not intended to make it more difficult to reach me. Mail to my old address will be forwarded for the next few years, and if my phone rings more than four times now, the secretary (Edie) should answer (theoretically). Here's my new address and phone:

Bob Dietrich
MS 92-134
Tektronix, Inc. phone: (503) 645-6464 ext 1727
P.O. Box 500
Beaverton, Oregon 97077
U.S.A.

For those of you that are still trying to convince other people that Pascal has 'arrived', I put together this short list of companies. It consists solely of those companies that both manufacture processors and have announced a version of Pascal on one or more of their products. Hopefully I have not left out anyone. Due to my own lack of information only U.S. companies are listed.

American Microsystems
Basic Timesharing
Control Data Corporation
Data General
Digital Equipment Corporation
General Automation
Hewlett-Packard
Honeywell
IBM
Intel
Motorola
National Semiconductor
Texas Instruments
Three Rivers Computer
Varian division of Sperry Univac
Western Digital
Zilog

Of course, this list does not include the many more companies that supply Pascals for the xyz computer. Often (and why not?) these companies do a much better job than the companies that actually build the processors. You can draw your own conclusions from this list.

Validation Suite Reports

The University of Tasmania

Postal Address: Box 252C, G.P.O., Hobart, Tasmania, Australia 7001
Telephone: 23 0561. Cables 'Tasuni' Telex: 58150 UNTAS

IN REPLY PLEASE QUOTE:
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14th March, 1980

The Editor,
Pascal News.

Validation Suite Report

This report to readers of *Pascal News* is intended to let everyone know of our intentions and plans. The demand for the validation package and response to it has almost swamped our capability of replying.

The current version 2.2 of the Validation Suite has been distributed to about 150 organizations or individuals, not counting the several thousands reached via *Pascal News*. As an indicator, the distribution list of our US distributor Rich Cichelli, is enclosed. Some suppliers are using the Validation Suite results in their advertising, and many are using it as a development tool. I have received a number of comparative reports, and have noticed a healthy competition to achieve 100% on the conformance/deviance tests.

We have almost completed an update to Version 2.3, which will correct the known errors in Version 2.2, and will include a few tests which were accidently omitted in the first release. Unfortunately, even with the greatest care we could muster, several erroneous programs slipped through into the release of 2.2, and a few had features which caused them to fail on some processors for unrelated reasons. Version 2.3 is the response to such problems. However, it is still derived from the version of the Draft Standard printed in Pascal News and IEEE Computer, and known in ISO circles as ISO/TC97/SC5-N462.

As soon as this is tested and released, we begin work on updating the whole package to the ISO Draft Standard now being circulated for voting. I estimate that this will take us about 2-3 months, for completely checking over 300 programs is non-trivial, and the insertions will require to be carefully drafted. The sources of change are primarily due to:

(i) areas in the earlier draft standards that were poorly drafted now being more precisely defined,

(ii) areas in the draft standard which have been altered, usually because N462 contained some mistake or ill-conceived change,

(iii) field experience with the package showing us weak spots in its attack strategies on compilers.

I should like to thank all those who have sent Brian, Rich or me copies of their results, or better still concise summaries and comments for the future. Your praise and criticisms help sustain us through a quite difficult piece of software engineering. Indeed we now realize that we should perhaps have written ourselves more tools at the start to carry through what I think to be a most significant piece of change in the software industry, and I am very much aware just how many contributions have gone up to make this effort.

May I simply continue to urge readers of Pascal News to keep on pushing the view that "correct is right" (with apologies to T.H.White), and to refuse to accept second-best.

Arthur Sale

Arthur Sale,
Professor of Information Science

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Provo, Utah 84602

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Sunnyvale, Calif 94086

Pascal

THE PASCAL VALIDATION PROJECT

Department of Information Science
University of Tasmania
GPO Box 252C,
HOBART, Tasmania; 7001

Validation Newsletter No 1

1980 March 28

Some time ago you acquired a version of the Pascal Validation Suite, either from us or from Rich Cichelli in the USA or from Brian Wichmann in the UK. If your version is up to date, you should have Version 2.2.

To briefly explain our numbering system for versions, the first digit identifies a major break in the evolution. Thus Version 1 related to the pre-1979 work derived from the Pascal User Manual and Report, and Version 2 is the completely revised package produced after receipt of the first public draft of a Pascal Standard (ISO/TC97/SC5 N462, known as Working Draft 3). The second number relates to a revision level within that major version.

With the release of Version 2.0, and its subsequent rapid evolution through 2.1 to 2.2, we have achieved a relatively stable product. It is by now quite well known that in the 350+ programs of the package there are a small set which are incorrect (they do not test what they ought to, or have a syntax error, or a convention error), and there is a small set which are not as well-designed as they might be (failing for reasons which are unrelated to their purpose). Accordingly, while I was on sabbatical leave from the University of Tasmania in 1979/80, Brian Wichmann and staff at the National Physical Laboratories in England produced a new version 2.3 which attempts to correct these errors, and which adds a number of new tests together with old ones which were omitted from version 2 but were in version 1.

We will not distribute this version, and it will remain purely an internal revision level. Of necessity, the first production of a new level must be tested before release, and our testing of version 2.3 yields many issues which would have to be clarified before we could distribute it with the confidence in its quality that you are entitled to expect.

Even more cogently, we consider the revision of the validation package to conform to the new Draft Proposal (DP7185) to be even more important than tidying up the loose ends of an obsolete version level, and accordingly our efforts are now going into producing that version as soon as possible. It will be known as Version 3.0, and will take us at least two or three months to complete.

In this way we think we can avoid delays in the production of 3.0 and minimize the circulation of spurious tests and those which are relevant to N462 but not to DP7185 (or worse, reversed in the two versions...)

While undertaking the major revision required to produce the new version, we shall also attempt to simplify some aspects of testing. Since Version 3.0 will be a major revision, we shall issue it complete (i.e. not an update issue), but we intend in future to include a "last revision level" in the header of each test to facilitate identifying the latest changes.

Thank you for your support of our effort; we have over 150 subscribers now and the activity is certainly paying off in terms of quality of software and convenience to users. Best wishes for your future work.

A.H.J. Sale

Professor A.H.J. Sale

The University of Tasmania

Postal Address: Box 252C, G.P.O., Hobart, Tasmania, Australia 7001

Telephone: 23 0561. Cables 'Tasuni' Telex: 58150 UNTAS

IN REPLY PLEASE QUOTE:

FILE NO.

IF TELEPHONING OR CALLING

ASK FOR

11th March, 1980

Mr. P. Pickelmann,
Computing Centre,
University of Michigan,
1075 Beal Avenue,
Ann Arbor, Michigan
U.S.A. 48109

Dear Paul,

Thank you for your letter, which I have just read after returning to Tasmania from study leave in USA and Europe. I was very excited to read it, as it seems a very thorough piece of work, and just the sort of thing we hoped the package would do.

I have taken the liberty of sending a copy of your report to Pascal News for reprinting; if you want it kept private please write to Rick Shaw and say so, or send revisions. I have also sent a copy to the AAEC (Jeff Tobias) as he has told me that his field test version passes all conformance and practically all deviance tests! (or at least the correct tests).

I do not think that a tape with all three tests would be of great use to me at present as we are about to shift up one sub-level in the tests, and a new version level is three months away (to conform to the new Draft Standard). I think I can glean all I need from your very comprehensive report.

On your "Distribution problems", etc:

1. Charset : will investigate.

2. Printfiles: the distributed skeleton program will readily paginate; I will not put control characters in for the few installations that want them, at the expense of making 99% of installations strip them off. The printed version was printed by a slight modification of the skeleton.

Errors in test programs : will investigate; most have been reported frequently (sigh; complete correctness of 350+ programs too much for us; and flaws like 6.2.1-7 slip through.)

Specific suggestions

Clock would be less standard than processtime. The name of a non-standard function is irrelevant; processtime is deliberately chosen so as not to be in anyone's system (except ours) and to return results in standard metric units (seconds). Consequently inadvertent rubbish results are unlikely.

The suggestion about [1 mod bitsperword] illustrates only poor quality compilation techniques. Our compiler and the ICL 1900 one should realize that the result is in the range 0..(bitsperword-1) anyway. Consequently I would prefer to keep the algorithm transparent rather than introduce extraneous variables whose whole purpose is to optimize less-than-perfect implementations. (As a matter of interest, I have been musing over a version with very large sets here; our implementation will handle them too.)

6.3.1 & 6.4.5-5 are slips; our compiler has full significance, and all the others I used for testing had 10 or 12 or 16 characters up to release. We also forgot to run the full package with our STANDARD switch set to enable the compiler to report these.

6.8.3.5-4 Perhaps maxint is a bit severe? We are seeking implementations which allow 'virtual infinity' of case, to show quality. (Our compiler will handle maxint of course, but I wouldn't condemn a compiler that had a hash-table algorithm with packed one-word records and hence was limited to less than maxint values as the key.)

LOOP. Agree. Didn't realize that anyone was foolish enough to use loop-exit until talking with IBM implementors.

For-loops: you are tackling things which were left out of Version 2 because I could not resolve them in advance of the Draft Standard (or at least tried to influence the Standard first).

VERSION indication is a good idea, which we had already noted, but not in so clear a form. Thanks.

Finally, can you send me your size in shirts? We have a free gift to validators who do good work for Pascal...

Yours sincerely,

Arthur Sale

Arthur Sale,
Information Science Department

IBM 370

THE UNIVERSITY OF MICHIGAN
COMPUTING CENTER
1075 BEAL AVENUE
ANN ARBOR, MICHIGAN 48109

January 22, 1980

Pascal Support
Department of Information Science
University of Tasmania
Box 252C, G.P.O.
Hobart 7000
Tasmania
Australia

Dear Sirs:

Here is a copy of my first version of a Validation Report for three IBM 360/370 compilers, and some comments ans suggestions on the suite. I'll send another version after I finish adapting Release 3 of the Stony Brook compiler for MTS, which should fix several of the problems.

If you are interested, I could send a tape with the results for all three compilers.

Sincerely,

Paul

Paul Pickelmann

PP:kls

Enclosure

Dear Readers of Pascal News,
I am sending these reports to News to show an example (a good one) of the flood of information I am receiving on validation. See the report by me also in the News.
Arthur Sale

PASCAL VALIDATION SUITE REPORT

Pascal Processor Identification

Computer: IBM 360/370, Amdahl 470 ...

Amdahl 470/V7 used for tests

Processors:

AAEC - Pascal/8000 (MTS version) Version 1.2/F79

STBR - Stony Brook Compiler (MTS version) Release 2.1/CT129

UBC - University of British Columbia Version Aug.16/79

Test Conditions

Tester: Paul Pickelmann (University of Michigan)

Date: January 1980

Version: 2.2

A Note on a Bit of Ambiguity

by:	it is ment
Parameter	A parameter of any kind (value, var, procedure, or function) of a procedure or function.
Procedure Parameter	A parameter of a procedure or function which is a procedure or function.

The "Pascal Validation Suite" is a set of 318 Pascal programs designed to test a compiler for compliance with the draft Pascal standard. A full listing of the suite along with Arther Sale's delightful introduction is in Pascal News,16 (October 1979 arrived Jan.80). The results of running the 3 Pascal compilers available on MTS are summerized below. A full report is in UNSP:PASCAL.NEWS.

Version 2.2 of the suite was used. This corresponds to the version of the draft in Pascal News, 14 (Jan.79). There are at least two newer drafts and a new version of the suite is comming.

If the number of tests failed seems disapointing, note that the designers took care to test those things which have changed from one definition of Pascal to the next, as well as those (mostly errors) which are hard to deal with.

Test Type	#tests	Failed/Passed		
		AAEC	STBR	UBC
Coformance	139	17/122	26/113	21/118
Deviance	94	33/ 61	35/ 59	41/ 53
ErrorHandling	46	23/ 23	22/ 24	24/ 22
Implmentation	15	1/ 14	0/ 15	1/ 14
Quality	23	5/ 13	4/ 19	3/ 15
Extensions	1	1/ 0	1/ 0	1/ 0
Cost		$16.98	$10.20	$38.75

Conformance Tests

	AAEC	STBR	UBC
Number of tests passed =	122	113	118
Number of tests failed =	17	26	21

Failed Tests

AAEC
6.1.2-3, 6.1.8-3, 6.2.2-3, 6.3-1, 6.4.3.3-1, 6.4.3.3-4,
6.4.3.5-1, 6.4.3.5-2, 6.4.3.5-3, 6.5.1-1, 6.6.3.1-5, 6.6.3.4-2,
6.8.3.9-1, 6.8.3.9-7, 6.9.2-3, 6.9.4-4, 6.9.4-7

STBR
6.1.6-2, 6.2.1-6, 6.2.2-3, 6.2.2-8, 6.4.2.2-2, 6.4.3.3-1,
6.4.3.3-10, 6.4.3.5-1, 6.4.3.5-2, 6.4.3.5-3, 6.4.5-1, 6.6.3.1-1,
6.6.3.1-5, 6.6.3.2-1, 6.6.3.3-1, 6.6.3.4-2, 6.6.5.2-3, 6.6.5.2-4,
6.6.5.2-5, 6.6.6.2-3, 6.6.6.4-1, 6.6.6.5-1, 6.7.2.4-3, 6.8.3.9-7,
6.9.4-4, 6.9.4-15

UBC
6.1.3-2, 6.2.2-3, 6.2.2-8, 6.4.3.5-1, 6.4.3.5-2, 6.4.3.5-3,
6.5.1-1, 6.5.3.4-1, 6.6.3.1-1, 6.6.3.1-3, 6.6.3.1-5, 6.6.3.4-2,
6.6.5.2-3, 6.6.5.2-5, 6.6.6.2-3, 6.7.2.5-2, 6.8.3.9-7, 6.9.4-4,
6.9.4-15 6.9.4-6, 6.9.4-7,

Details of failed tests:

AAEC
Only the first eight characters of identifers and reserved words are used. Some longer identifers look like reserved words.
Failed 6.1.2-3 and 6.3-1

UBC
Upper and lower letters are considered distinct in identifers.
Failed 6.1.3-2

STBR
Labels are compared as strings so leading zeros are significant.
Failed 6.1.6-2

AAEC
In "(*...}" and "{...*)" the starting and ending delimiters don't match but are considered the entire comment, which is what later versions of the draft standard require.
Failed 6.1.8-3

STBR
The program-parameters part of the program-heading is not optional.
Failed 6.2.1-6, 6.6.3.2-1, 6.6.3.3-1, and 6.6.6.5-1

AAEC, STBR, UBC
When declaration for a type which is the domain of a pointer type appears after the declaration of the pointer type and there is a more global type with the same name, the more global type is used for the domain of the pointer instead of the locally declared type.
Failed 6.2.2-3

STBR, UBC
Assignment to a function identifer is not permitted from within nested procedures and functions.
Failed 6.2.2-8.

STBR
The cardinality of subranges must be less than Maxint. Programs will run as long as these are never assigned a value greater than Min(subtype)+Maxint.
Failed 6.4.2.2-2 (error message, but runs)

STBR
The tag-field is required in varient records.
Failed 6.4.3.3-1

AAEC
Empty record declarations containing a semicolon produce syntax errors.
Failed 6.4.3.3-1

AAEC
The tag-field may not redefine an identifer elsewhere in the declaration part.
Failed 6.4.3.3-4

STBR
Case constants outside the tag-field subrange are not allowed, which is what later versions of the draft standard require methinks.
Failed 6.4.3.3-10

AAEC, STBR, UBC
Pointers are not allowed within files.
Failed 6.4.3.5-1

AAEC
Null and length one lines have a blank appended when written.
Failed 6.4.3.5-2

STBR, UBC
Null lines are replaced by length one lines when written.
Failed 6.4.3.5-2, 6.4.3.5-3

STBR
To solve the "interactive file problem" fâ is undefined until eof is checked.
Failed 6.4.3.5-2, 6.6.5.2-4
There is a bug where an eof check is need when it shouldn't be.
Failed 6.4.3.5-3

UBC
The end-of-line character is eol not ' '
Failed 6.4.3.5-2

UBC
Local files (those other than program parameters) are not really local. They must be provided by the user and all files with the same name use the same file.
Failed 6.4.3.5-2, 6.4.3.5-3, 6.5.3.4-1, 6.6.3.1-3, 6.6.5.2-3
6.6.5.2-5, 6.9.4-15

AAEC
Reset does not do an implicit writeln (except with output)
Failed 6.4.3.5-3

STBR
Assignment to a var parameter whose type is an alis for the type of the value assigned gives an error message and causes the compiler to program interupt.
Failed 6.4.5-1

AAEC, UBC
Records may not contain files.
Failed 6.5.1-1

STBR, UBC
An actual parameter of some type for a var parameter which is a subrange of that type is not allowed. This is what the draft standard requires; the test is in error.
Failed 6.6.3.1-1

AAEC, STBR, UBC
Test has error. A parameter is included with a procedure parameter.
Failed 6.6.3.1-5

AAEC, STBR
The syntax for the par-list of procedure parameters is diferent.
UBC
Full specification(par-list) of procedure parameters is not allowed.
Failed 6.6.3.1-5, 6.6.3.4-2

AAEC, UBC
Cann't have procedure parameters with procedure parameters.
Failed 6.6.3.4-2

STBR, UBC
If the MTS-file which is used for a local file is not empty and the first thing done is reset, the file is not empty and eof is not true.
Failed 6.6.5.2-3

STBR
Eof used with file being written causes an error.
Failed 6.6.5.2-5

STBR
Test 6.6.6.2-3 requires too much precision of real functions.
UBC
The experession Arctan(0)=0 yeilds false even though Arctan(0) yeilds 0.
Failed 6.6.6.2-3

STBR
Ord returns different values when applied to variables of a subtype and it's basetype which have the same value. Specifically Ord(min(subtype))=0.
Failed 6.6.6.4-1

STBR
The expersion "A * (. .)" causes a run error.
Failed 6.7.2.4-3

UBC
The expersion "(.0,1.) <= A" causes a run error.
Failed 6.7.2.5-2

AAEC
In a for loop the assignment is done before the second experession is evaluated.
Failed 6.8.3.9-1

AAEC,STBR,UBC
Extreme valuse in for loops cause problems. UBC infinite loops, AAEC and STBR cause run errors.
Failed 6.8.3.9-7

AAEC
Real numbers are converted diferently at compile time than at run time.
Failed 6.9.2-3.

AAEC,STBR,UBC
The formating of reals when the field width given is too small is wrong. Test is likely wrong, as the draft standard is not clear. This section is changed in later drafts.
Failed 6.9.4-4

UBC
Strings are left justified, not right justified as the should be.
Failed 6.9.4-6

AAEC,UBC
' TRUE' instead of 'TRUE ' is used when writing booleans. This may be changed in later versions of the standard.
Failed 6.9.4-7

STBR
Due to a bug, local files which are not global may not be used. Release 3 will fix this and many other problems with files.
Failed 6.9.4-15

Deviance Tests

		AAEC	STER	UBC
Number of deviations detected	=	61	59	53
Number of undetected extensions	=	1	4	3
Number of deviations not detected	=	32	31	38

Failed Tests

AAEC
6.1.2-1, 6.1.7-7, 6.1.7-8, 6.1.7-11, 6.2.1-5, 6.2.2-4,
6.2.2-9, 6.3-6, 6.4.1-2, 6.4.1-3, 6.4.5-2, 6.4.5-3,
6.4.5-13, 6.4.5-4, 6.4.5-5, 6.6.2-5, 6.6.3.5-2, 6.6.3.6-2,
6.6.3.6-3, 6.6.3.6-4, 6.6.3.6-5, 6.8.2.4-2, 6.8.2.4-3, 6.8.2.4-4,
6.8.3.9-2, 6.8.3.9-3, 6.8.3.9-4, 6.8.3.9-9, 6.8.3.9-13,6.8.3.9-14,
6.8.3.9-16,6.8.3.9-19

STER
6.1.7-5, 6.1.7-6, 6.10-1, 6.10-3, 6.2.1-5, 6.2.2-4,
6.3-2, 6.3-3, 6.3-4, 6.3-5, 6.4.3.2-5, 6.4.4-2,
6.4.5-13, 6.4.5-3, 6.4.5-4, 6.4.5-5, 6.6.1-6, 6.6.2-5,
6.6.6.3-4, 6.7.2.2-9, 6.8.2.4-2, 6.8.2.4-3, 6.8.2.4-4, 6.8.3.5-10,
6.8.3.9-2, 6.8.3.9-3, 6.8.3.9-4, 6.8.3.9-9, 6.8.3.9-14,6.8.3.9-16,
6.8.3.9-19

UBC
6.1.7-5, 6.1.7-6, 6.10-1, 6.10-3, 6.2.1-5, 6.2.2-4,
6.3-2, 6.3-3, 6.3-4, 6.3-5, 6.4.1-3, 6.4.3.1-1,
6.4.3.1-2, 6.4.3.2-5, 6.4.5-3, 6.4.5-5, 6.4.5-10, 6.4.5-11,
6.4.5-13, 6.6.2-5, 6.6.3.5-2, 6.6.3.6-2, 6.6.3.6-3, 6.6.3.6-4,
6.6.3.6-5, 6.7.2.2-9, 6.8.2.4-2, 6.8.2.4-3, 6.8.2.4-4, 6.8.3.9-2,
6.8.3.9-3, 6.8.3.9-4, 6.8.3.9-9, 6.8.3.9-11,6.8.3.9-13,6.8.3.9-14,
6.8.3.9-16,6.8.3.9-19,

Undetected extensions

AAEC
6.9.4-9

STER
6.1.5-6, 6.8.3.5-12,6.9.4-9, 6.9.4-12

UBC
6.1.5-6, 6.9.4-9, 6.9.4-12

Details of deviations not detected

AAEC
Nil is not reserved.
Failed 6.1.2-1

STER,UBC
Packed and unpacked arrays are considered equivalent.
Failed 6.1.7-5

STER,UBC
Strings are compatiable with arrays of length n, not just those with index 1..n.
Failed 6.1.7-6, 6.4.3.2-5

AAEC
Strings are compatiable with arrays of subrange of char.
Failed 6.1.7-7 and 6.1.7-8

AAEC
Null strings are accepted.
Failed 6.1.7-11

AAEC,STER,UBC
Declared but unused labels are allowed.
Failed 6.2.1-5

AAEC,STER,UBC
With in a scope a global name may be used then redefined.
Failed 6.2.2-4

AAEC
Function identifers may be assigned to outside the bounds (text) of the function.
Failed 6.2.2-9

STER,UBC
"+" (but not "-") may be used on things of type CHAR, string, and scalars, not just integers and reals.
Failed 6.3-2, 6.3-3, 6.3-4, 6.3-5, and 6.7.2.2-9

AAEC
A name may be used in it's own definition e.g. "const ten=ten;"
Failed 6.3-6, and 6.4.1-2

AAEC,UBC
A global name may be used within a record which redefines that name.
Failed 6.4.1-3

UBC
Allows packed anything not just (direct) structures.
Failed 6.4.3.1-1, and 6.4.3.1-2

STER
Pointers to undeclared types may be used, but not dereferenced.
Failed 6.4.4-2

UBC
Comparisons are allowed between diferent types.
Failed 6.4.5-10 and 6.4.5-11

AAEC,STER,UBC
The P4 definition of type equivalence rather than the stricter current definition.
Failed 6.4.5-3, 6.4.5-4(AAEC,STER), 6.4.5-5, 6.4.5-13

AAEC
A compatible type is allowed as a var parameter.
Failed 6.4.5-2

STBR
Missing FORWARD procedures go undetected.
Failed 6.6.1-6

AAEC,STBR,UBC
Missing assignment to a function identifer goes undetected.
Failed 6.6.2-5

AAEC
Actual function paramaters returning types compatible with the formal function parameter are allowed.
Failed 6.6.3.5-2

AAEC,UBC
Actual and formal procedure parameters may have parameters which are compatible, not just the same.
Failed 6.6.3.6-2, and 6.6.3.6-3

STBR
Trunc and Round with integer arguments get by.
Failed 6.6.6.3-4

AAEC,STBR,UBC
Goto's are allowed between then and else parts of if statements and between cases in a case statement. A later draft alowed this, but it looks like it's out of the current one, which is too bad at least in the case of the case statements.
Failed 6.8.2.4-2, and 6.8.2.4-3

AAEC,STBR,UBC
Goto's are allowed into structured statements. See the test for some interesting implications of this and the definition in the draft.
Failed 6.8.2.4-4

STBR
Real case selectors get by (when the case constants are reals).
Failed 6.8.3.5-10

UBC
Components of records are allowed as for loop variables.
Failed 6.8.3.9-11

AAEC,STBR,UBC
Non-local variables are allowed as for loop variables.

Assignments to for loop variables inside the loop are allowed.

Nested for loops with the same variable are allowed. In STBR this doesn't cause infinite loops, since at the top of the loop the variable gets the value it would have if not changed.
Failed 6.8.3.9-2, 6.8.3.9-3, 6.8.3.9-4, 6.8.3.9-9, 6.8.3.9-14, 6.8.3.9-16, and 6.8.3.9-19

STBR,UBC
Output may be used even if it doesn't appear in the program header.
Failed 6.10-1

STBR,UBC
Write may be used without specifing a file even when output has been declared.
Failed 6.10-3

Details of extensions not detected

STBR,UBC
'e' for 'E' is allowed in real constants. Later drafts allow this.
Failed 6.1.5-6

STBR
Subranges in case lists are not flaged as extensions. (Version 2S of the compiler doesn't allow them though).
Failed 6.8.3.5-12

AAEC,STBR,UBC
Zero and negitive field widths are allowed. Later drafts may allow this.
Failed 6.9.4-9,

STBR,UBC
Write works with unpacked arrays of char, not just packed ones.
Failed 6.9.4-12

Tests failed for non-conformance

UBC
Fully specified parameter lists are not allowed.
Failed 6.6.3.5-2, 6.6.3.6-2, 6.6.3.6-3, 6.6.3.6-4, and 6.6.3.6-5

AAEC
Procedure parameters may have only value parameters.
Failed 6.6.3.6-3, and 6.6.3.6-4

AAEC,UBC
Loop is a reserved word.
Failed 6.8.3.9-9, 6.8.3.9-13, and 6.8.3.9-14

Error-Handling

	AAEC	STBR	UBC
Number of errors detected =	23	24	22
Number of errors not detected =	23	22	24

Failed Tests

AAEC
6.2.1-7, 6.4.3.3-5 ,6.4.3.3-6, 6.4.3.3-7, 6.4.3.3-8, 6.4.3.3-12,
6.4.6-7, 6.4.6-8, 6.6.2-6, 6.6.5.2-6, 6.6.5.2-7, 6.6.5.3-3,
6.6.5.3-4, 6.6.5.3-5, 6.6.5.3-6, 6.6.5.3-7, 6.6.5.3-8, 6.6.5.3-9,
6.7.2.2-6, 6.7.2.4-1, 6.8.3.9-5, 6.8.3.9-6, 6.8.3.9-17

STBR
6.2.1-7, 6.4.3.3-5, 6.4.3.3-6, 6.4.3.3-7, 6.4.3.3-8, 6.4.6-7,
6.4.6-8, 6.6.2-6, 6.6.5.2-2, 6.6.5.2-6, 6.6.5.2-7, 6.6.5.3-3,
6.6.5.3-4, 6.6.5.3-5, 6.6.5.3-6, 6.6.5.3-7, 6.6.5.3-8, 6.6.5.3-9,
6.7.2.4-1, 6.8.3.9-5, 6.8.3.9-6, 6.8.3.9-17

UBC
6.2.1-7, 6.4.3.3-5, 6.4.3.3-6, 6.4.3.3-7, 6.4.3.3-8, 6.4.3.3-12,
6.6.2-6, 6.6.5.2-6, 6.6.5.2-7, 6.6.5.3-3, 6.6.5.3-4, 6.6.5.3-5,
6.6.5.3-6, 6.6.5.3-7, 6.6.5.3-8, 6.6.5.3-9, 6.6.6.3-2, 6.6.6.3-3,
6.7.2.2-6, 6.7.2.2-7, 6.7.2.4-1, 6.8.3.9-5, 6.8.3.9-6, 6.8.3.9-17

Details of failed tests:

AAEC,STBR,UBC
Use of undefined variables is not detected.
Failed 6.2.1-7, 6.4.3.3-6, 6.4.3.3-7, 6.4.3.3-8, 6.6.2-6,
6.8.3.9-5 6.8.3.9-6

AAEC
Use of an null record causes an operation exception.
STBR
Use of a null record is considered an incompatible assignment.
UBC
Use of a null record which is therefor an undefined variable is not detected.
Fails 6.4.3.3-12

AAEC,STBR,UBC
Varient errors are undetected
Failed 6.4.3.3-5

AAEC,STBR,UBC
Set assignments out of range are not detected. Comments in 6.7.2.4-1 say something about "operations on overlaping sets" but I cann't find section 6.7.2.4!
Failed 6.4.6-7(AAEC,STBR), 6.4.6-8(AAEC,STBR), 6.7.2.4-1

STBR
Get with eof true is not detected.
Failed 6.6.5.2-2

AAEC,STBR,UBC
Put while F@ is a parameter to a procedure is not detected. The test has a value parameter and this may not be an error unless it is a var par.
Failed 6.6.5.2-6

AAEC,STBR,UBC
F@ being changed while it is in use by a with statement is not detected.
Failed 6.6.5.2-7

AAEC,STBR,UBC
Dispose does nothing so it does not detect things which may not be disposed, nil, undefined, or active variables.
Failed 6.6.5.3-3, 6.6.5.3-4, 6.6.5.3-5, and 6.6.5.3-6

AAEC,STBR,UBC
Records created with the varient form of new have the same size as others. Violations of the restrictions on use of these are not detected.
Failed 6.6.5.3-7, 6.6.5.3-8, and 6.6.5.3-9

UBC
Trunc and round do not detect values greater than maxint.
Failed 6.6.6.3-2, and 6.6.6.3-3

AAEC,UBC
Results of (some) operations which are outside -maxint..maxint are not detected.
Failed 6.7.2.2-6, 6.7.2.2-7(UBC)

AAEC,STBR,UBC
As with 6.8.3.9-19, no errors for nested for loops with the same variable. AAEC,UBC go into infinite loops
Failed 6.8.3.9-17

Quality Measurement

	AAEC	STBR	UBC
Number of tests run =	18	23	18
Number incorrectly handled =	5	4	3

Failed Tests

AAEC
5.2.2-1, 6.1.3-3, 6.1.8-4, 6.4.3.4-5, 6.6.1-7, 6.8.3.5-2, 6.8.3.9-18

STBR
6.1.8-4, 6.4.3.2-4, 6.8.3.5-2, 6.8.3.5-8,

UBC
6.1.8-4, 6.4.3.2-4, 6.8.3.5-2

Tests not run

AAEC, UBC
6.6.6.2-6, 6.6.6.2-7, 6.6.6.2-8, 6.6.6.2-9, 6.6.6.2-10

Details of failed tests:

AAEC
No warning is given for long identifers, and only the first eight characters are used.
Failed 5.2.2-1, 6.1.3-3

AAEC,STBR,UBC
No warning is given for a (short) comment with a missing "}".
Failed 6.1.8-4

STBR,UBC
Array(.integer.) confusses the compiler and causes an obscure things at run-time.
Failed 6.4.3.2-4

AAEC
(.1 mod bitsperword .) is not done correctly. Worked when changed to (.t.) where t was 0..bitsminus1.
Failed 6.4.3.4-5

AAEC
Procedure nesting is limited to 6 levels (main,P1..P5).
Failed 6.6.1-7

AAEC,STBR,UBC
No warning is given for an impossible case, one whose label is outside the subrange of the selector. This maybe an error in later drafts.
Failed 6.8.3.5-2

Implementation-Dependence

	AAEC	STBR	UBC
Number of tests run =	15	15	15
Number incorrectly handled =	1	0	1

Tests Incorrectly Handled

AAEC
There was an integer overflow evaluation trunc((a+b)-a) which should have returned 16.
Failed 6.6.6.2-11

UBC
Set of char should work, but doesn't always
Failed 6.4.3.4-2

Test Results

Test 6.4.2.2-7
AAEC,STBR,UBC
Maxint = 2,147,483,647

Test 6.4.3.4-2
AAEC,UBC
Set of char is allowed.
UBC
Set of char is allowed and should work, but the test fails.

Test 6.4.3.4-4
AAEC
Sets of 0..1000 are allowed. Range is 0..2047.
STBR
Sets of 0..1000 are allowed. Any subrange with 2048 or fewer members can be the base type for a set. Set constructor works only on scalars and subranges, not integers.
UBC
Sets of 0..1000 not allowed. Base types may have upto 256 members. Set constructor only works with numbers in 0..255.

Test 6.6.6.2-11
AAEC
There is an integer overflow in trunc(expr=16.0), only with this program (??).
STBR
Beta=16, T=6, Rnd=0, Ngrd=1, Machep=-5, Negexp=-6, Iexp=7, Minexp=-65, maxexp=63, eps=9.53674316e-07, epsneg=5.96046448e-08, xmin=5.39760535e-79,xmax=7.23700515e+75
UBC
Beta=16, T=16,Rnd=0, Ngrd=1, Machep=-13,Negexp=-14,Iexp=7, Minexp=-65, maxexp=63, eps=2,22044605e-16, epsneg=1.38777878e-17, xmin=5.39760535e-79,xmax=7.23700558e+75

Tests 6.7.2.3-2, 6.7.2.3-3
AAEC,UBC
Boolean experessions are fully evaluated. UBC has option to use

partial evaluation.
STBR
MacCarthy evaluation of boolean experessions is used.

Tests 6.8.2.2-1, 6.8.2.2-2
AAEC,UBC
Tests show selection before evaluation.
STBR
First test shows selection before evaluatio, second evaluation before selection.

Tests 6.9.4.5, 6.9.4-11
AAEC
Default field widths for integers 12, reals 24, booleans 5. Exponents have 2 digits.
STBR
Default field widths for integers 12, reals 14, booleans 6. Exponents have 2 digits.
UBC
Default field widths for integers 10, reals 22, booleans 10. Exponents have 2 digits.

Test 6.6.6.1-1
AAEC,UBC
No standard procedures may used as procedure parameters.
STBR
Only Sin, Cos, Exp, Ln, Sqrt, and Arctan may be used as procedure parameters.

Test 6.10-2
AAEC,STBR
Rewrite(output) is not allowed.
UBC
Rewrite(output) is allowed.

Test 6.11-1, 6.11-2, 6.11-3
AAEC,STBR,UBC
These subistute symbols are allowed and no others

```
               "(*" "*)"  for  "}" "{"
               "(." ".)"  for  "[" "]"
                  "@"     for    "↑"
```

STBR
There is a limit on the size of any one procedure which is about 200 statements. This could be easily increased, but this is the only program known to exceed it.
Failed 6.8.3.5-8

Details of tests not run

AAEC, UBC
These tests used upper case identifers declared in lower case and had 'e' in real constants.
6.6.6.2-6, 6.6.6.2-7, 6.6.6.2-8, 6.6.6.2-9, 6.6.6.2-10

Results of Tests

Test 6.1.3-3
AAEC
Only the first 8 characters of an identifer are used.
STBR,UBC
Tests reports more than 20 characters of identifers used. STBR uses all characters, UBC uses 32.

Test 6.4.3.3-9
AAEC,STBR,UBC
The tag-field in records is not checked. Test reports 'exact correlation'

Test 6.4.3.4-5
Measures the time for Warshall's algorithm on a 80x80 matrix.
Original uses array(.0..79.) of array(.0..4.) of set of 0..15.
Modified uses array(.0..79.) of set of 0..79.

	Original		Modified	
	time(sec)	size(words/bits)	time(sec)	size(words/bits)
AAEC	0.087	502/16064	0.021	388/12416
STBR	0.060	400/12800	0.020	310/ 9920
UBC	0.089	670/21440	0.035	562/17984

Test 6.7.2.2-4
AAEC,STBR,UBC
Div and mod with negative operands are as in the latest draft. A div B = Trunc(A/B), and mod returns the remainder of div, that is it has the same sign as the quotient.

Test 6.8.3.9-18
AAEC
After a for loop the loop variable may have a value which is out of range.
STBR,UBC
After a for loop the loop variable has value of the finial expression.

Test *** (All)
The total cost of running all 318 programs was:
AAEC $16.98
STBR $10.20 done Compile and Execute, several compilations per run
UBC $38.75 done with LOADNGO

Burroughs B6700

PASCAL VALIDATION SUITE REPORT

Pascal Processor Identification

Computer: Burroughs B6700

Processor: B6700 Pascal version 3.0.001
(University of Tasmania compiler)

Test Conditions

Tester: R.A. Freak (implementation/maintenance team member)

Date: March 1980

Validation Suite Version: 2.2

Conformance Tests

Number of tests passed: 137

Number of tests failed: 1

Details of failed tests:

Test 6.4.3.5-1 fails because a file of pointers or a file of sets is not permitted.

Deviance Test

Number of deviations correctly detected: 83

Number of tests showing true extensions: 2 (2 actual extensions)

Number of tests not detecting erroneous deviations: 9 (5 basic causes)

Number of tests failed: 0

Details of extensions:

Test 6.1.5-6 shows that the lower case e may be used in real numbers (for example 1.602e-20). This feature has been included in the new draft standard.

Test 6.10-1 shows that the file parameters in the program heading are ignored in B6700 Pascal.

Details of deviations not detected:

Test 6.1.2-1 shows that nil may be redefined.

Tests 6.2.2-4, 6.3-6 and 6.4.1-3 show that a common scope error was not detected by the compiler.

Tests 6.8.2.4-2, 6.8.2.4-3 and 6.4.2.4-4 show that a goto between branches of a statement is permitted.

Test 6.9.4-9 shows that integers may be written with a negative format.

Test 6.10-3 shows that the file output may be redefined at the program level.

Error Handling

Number of errors correctly detected: 33

Number of errors not detected: 13 (4 basic causes)

Details of errors not detected: The errors not detected fall into a number of categories -

Tests 6.4.3.3-5, 6.4.3.3-6, 6.4.3.3-7 and 6.4.3.3-8 indicate that no checking is performed on the tag field of variant records.

Tests 6.6.5.2-1 and 6.6.5.2-7 indicate that a file buffer variable can be altered illegally and a put may be performed on an input file.

Tests 6.6.5.3-3, 6.6.5.3-4, 6.6.5.3-5 and 6.6.5.3-6 fail because dispose always returns a nil pointer in B6700 Pascal and no check is performed on the pointer parameter.

Tests 6.6.5.3-7, 6.6.5.3-8 and 6.6.5.3-9 fail because no checks are inserted to check pointers after they have been assigned a value using the variant form of new.

Implementationdefined

Number of tests run: 15

Number of tests incorrectly handled: 0

Details of implementation-dependence:

Test 6.4.2.2-7 shows maxint to be 549755813887.

Tests 6.4.3.4-2 and 6.4.3.4-4 show that large sets are allowed. The maximum set size is 65536 elements. A set of char is permitted.

Test 6.6.6.1-1 shows that some standard functions can be passed as parameters. Those which use in-line code cannot be passed as parameters.

Test 6.6.6.2-11 details some machine characteristics regarding number formats.

Tests 6.7.2.3-2 and 6.7.2.3-3 show that boolean expressions are fully evaluated.

Tests 6.8.2.2-1 and 6.8.2.2-2 show that a variable is selected before the expression is evaluated in an assignment statement.

Tests 6.9.4-5 and 6.9.4-11 show that the default size for an exponent field on output is 2; for a real number it is 15; for a boolean 5 and the size varies for integers according to the value being written.

Test 6.10-2 indicates that a rewrite on the standard file output is permissible.

Tests 6.11-1, 6.11-2 and 6.11-3 show that the alternative comment delimiters have been implemented, as have the alternative pointer symbols. No other equivalent symbols have been implemented.

Quality Measurement

Number of tests run: 23

Number of tests incorrectly handled: 0

Results of tests:

Test 5.2.2-1 shows that identifiers are distinguished over their whole length.

Test 6.1.3-3 shows that more than 20 significant characters may appear in an identifier, in fact, the number of characters in a line is allowed.

A warning is produced if a semicolon is detected in a comment (test 6.1.8-4).

Tests 6.2.1-8, 6.2.1-9 and 6.5.1-2 indicate that large lists of declarations may be made in each block.

An array with an integer indextype is not permitted (test 6.4.3.2-4).

Test 6.4.3.3-9 shows that variant fields of a record occupy the same space, using the declared order.

Test 6.4.3.4-5 (Warshall's algorithm) took 0.698304 secs CPU on the Burroughs B6700 and 158 bytes.

Tests 6.6.1-7, 6.8.3.9-20 and 6.8.3.10-7 show that procedures, for statements and with statements may each be nested to a depth greater than 15.

Tests 6.6.6.2-6, 6.6.6.2-7, 6.6.6.2-8, 6.6.6.2-9 and 6.6.6.2-10, tested the sqrt, atan, exp, sin/cos and ln functions and all tests were successfully completed, without any significant errors in the values.

Test 6.7.2.2-4 shows that div has been implemented consistently for negative operands, returning trunc. mod returns for the remainder of div.

Test 6.8.3.5-2 shows that case constants must be of the same type as the case-index, if the case-index is a subrange, and a warning is given for case constants which cannot be reached.

Test 6.8.3.5-8 shows that a large case statement (256 selections) is permissible.

Test 6.8.3.9-18 indicates that range checking is always used in a case statement after a for statement to check the for variable.

Test 6.9.4-10 shows that file buffers are flushed at the end of a block and test 6.9.3-14 indicates that recursive I/O using the same file is allowed.

Extensions

Number of tests run: 1

Test 6.8.3.5-14 shows that the otherwise clause in a case statement has been implemented according to the accepted convention.

Data General Eclipse

PASCAL VALIDATION SUITE REPORT

PASCAL Processor Identification

Computer:	Data General Eclipse S/130
Processor:	Medical Data Consultants BLAISE (PASCAL P4 v4 DEC 1979)

Test Conditions

Tester:	Ted C. Park
Date:	April, 1980
Validation Suite Version:	2.2

General Comments

1. The overall quality and completeness of the validation programs is excellent.

2. The orthagonality of the programs is poor. Oftentimes many things are checked in one test. For instance, my compiler supports TRUNC but not ROUND. Since these are checked in the same test, this causes problems.

3. The skeleton program seems like a good idea but in actual practice it did me very little good. I wonder if it's really helpful to anyone else.

4. The skeleton program requires a "dummy" terminating program at the end of the validation suite. There is none.

5. The first line of program 6.8.3.4-1 is missing a comma.

6. Program 6.6.1-6 is missing a semicolon on the next to the last statement.

The PASCAL-P4 Subset

MDC "BLAISE" is based on PASCAL-P4 which is a known subset of PASCAL as described in Jensen and Wirth. It was not clear at the outset how a subset compiler would react to the validation programs. All the programs were submitted to the compiler and although many were invalid due to the known design restrictions, I am pleased to report that the compiler either accepted each program or printed appropriate diagnostic messages in every case. No program caused any system failure or crash either at compile or run time.

The known design constraints of PASCAL-P4 (See PASCAL NEWS #11, Page 70) are listed below.

NIL is a predeclared constant
FORWARD is a reserved word
Only the alternate form of comment delimiters are allowed
No MAXINT
No TEXT
No ROUND
No PAGE
No DISPOSE
No REWRITE
No RESET
No PACK
No UNPACK
The program heading is not required
Every variant record must have a tag field
No user declared files or associated features (BLAISE does not support GET or PUT)
No output of BOOLEANs
No output of REALs in fixed notation
No formal parameter functions or procedures
No subrange set constructors
64 character ASCII character set which implies upper case letters only.
No literal text strings longer than 16 characters.
8 character limit on identifier lengths.

Since the upper case only and 16 character literal string length restrictions applied universally to almost all programs, they were all adjusted accordingly. Other than that, no changes were made to any of the programs. The results are reported below.

Conformance Tests

Number of tests attempted:	139
Number of tests invalid due to known design restrictions:	31
Number of tests passed:	102
Number of tests failed:	6

Details of Failed Tests

Test 6.1.5-2 failed because long REALs are not accepted by the compiler, however, a warning message was issued.

Test 6.2.2-3 failed due to a scoping error.

Test 6.4.3.5-4 failed because no end of line was inserted at final buffer flush.

Test 6.8.2.4-1 failed because non-local GOTOs are not allowed.

Test 6.8.3.5-4 failed because of the large table generated for a sparse CASE statement.

Test 6.8.3.9-1 failed because the index of a FOR statement was set up before the final expression of the FOR statement was evaluated.

Deviance Tests

Number of tests attempted:	94
Number of tests invalid due to known design restrictions:	21
Number of tests passed:	50
Number of tests failed:	23

Details of Failed Tests

Test 6.1.7-8 failed because any character may be assigned to an element whose type is subrange of CHAR.

Test 6.2.2-4 fails to detect the scope overlap.

Test 6.3-5 fails because it allows a signed character constant.

Test 6.3-6 fails because it allows a constant to be used in its own declaration.

Test 6.4.1-3 fails because it allows a type to be used in its own declaration.

Test 6.4.5-2 fails because subranges of the same host are treated as identical.

Test 6.4.5-3 fails because similar arrays are treated as identical.

Test 6.4.5-4 fails because similar records are treated as identical.

Test 6.4.5-5 fails because similar pointers are treated as identical.

Test 6.6.2-5 fails because assignment to the function identifier is not required.

6.6.6.4-6 fails because SUCC and PRED are allowed for REALs.

Test 6.7.2.2-9 fails because the unary plus is allowed for a variable of type CHAR.

Test 6.8.2.4-2 fails because jumps between branches of an IF statement are allowed.

Test 6.8.2.4-3 fails because jumps between branches of a CASE statement are allowed.

Test 6.8.3.9-2 fails because assignment to the FOR index is allowed.

Test 6.8.3.9-3 fails because assignment to the FOR index is allowed.

Test 6.8.3.9-4 fails because assignment to the FOR index is allowed.

Test 6.8.3.9-9 fails because a non-local variable is allowed as a FOR index.

Test 6.8.3.9-14 fails because a global variable is allowed as a FOR index.

Test 6.8.3.9-16 fails because the FOR index can be read.

TEST 6.8.3.9-19 fails because nested FORs with the same index are not detected.

Test 6.9.4-9 fails because zero and negative field widths allowed are for integer output.

Test 6.9.4-12 fails because output of non-packed arrays is allowed.

Error Handling Tests

	Total tests attempted:	46
	Number of tests invalid due to known design restrictions:	13
	Number of tests passed:	8
*	Number of tests passed only if "DEBUG" option selected:	11

Number of tests failed: 14

Details of Failed Tests

Test 6.2.1-7 local values are not undefined prior to definition.

Test 6.4.3.3-5 other variants do not cease to exist when tag field changed.

Test 6.4.3.3-6 variants are not undefined prior to definition.

Test 6.4.3.3-12 empty field is not flagged as undefined prior to definition.

* Test 6.4.6-4 out of range not detected on integer assignment.

* Test 6.4.6-5 out of range not detected on integer parameter passing.

* Test 6.4.6-6 out of range not detected on integer array index.

* Test 6.4.6-7 out of range not detected on set assignment.

* Test 6.4.6-8 out of range not detected on set parameter passing.

* Test 6.5.3.2-1 out of range not detected on two dimensional integer array index.

* Test 6.5.4-1 pointer equals NIL not detected at use.

Test 6.5.4-2 pointer undefined not detected at use.

Test 6.6.2-6 function having no value assigned to it as undetected.

Test 6.6.5.3-7 assignment compatibility of records not checked.

Test 6.6.5.3-8 assignment compatibility of records not checked.

Test 6.6.5.3-9 assignment compatibility of records not checked.

* Test 6.6.6.4-4 SUCC function applied to last value not detected.

* Test 6.6.6.4-5 PRED function applied to first value not detected.

* Test 6.6.6.4-7 character out of range not detected.

Test 6.7.2.2-3 divide by zero not detected.

Test 6.7.2.2-8 mod by zero not detected.

* Test 6.7.2.4-1 out of range SET values not detected.

Test 6.8.3.9-5 undefined FOR indexed after loop not detected.

Test 6.8.3.9-6 undefined FOR index after zero pass loop not detected.

Test 6.8.3.9-17 nested FOR using same index not detected.

Implementation-Defined Tests

Test 6.4.2.2-7 no MAXINT

Test 6.4.3.4-2 SET of CHAR allowed

Test 6.4.3.4-4 SET base-type size 0...63

Test 6.6.6.1-1 functions not allowed as parameters

Test 6.6.6.2-11 all floating-point tests OK

Test 6.7.2.3-2 (A AND B) fully evaluated

Test 6.7.2.3-3 (A OR B) fully evaluated

Test 6.8.2.2-1 left side of array assignment evaluated before right side

Test 6.8.2.2-2 left side of pointer assignment evaluated before right side

Test 6.9.4-5 two digits written for exponent

Test 6.9.4-11 IFW=10 RFW=20 BFW not allowed

Test 6.10-2 rewrite not allowed

Test 6.11-1 {} not allowed for comments

Test 6.11-2 equivalent symbols for ^ : ; : = [ ] not allowed

Test 6.11-3 equivalent symbols for < > <= >= <> not allowed

Quality Tests

Test 6.2.2-1 identifiers not distinquished past 8 characters

Test 6.1.3-3 identifier significance is 8 characters

Test 6.1.8-4 no help in locating unclosed comment

Test 6.2.1-8 >= 50 types allowed

Test 6.2.1-9 >= 50 labels allowed

Test 6.4.3.2-4 integer not allowed as index type

Test 6.4.3.3-9 reverse allocation of listed vars

Test 6.4.3.4-5 1.4 seconds - 916 bytes vs. .8 seconds - 143 bytes

Test 6.5.1-2 long declaration lists allowed

Test 6.6.1-7 procedures may be nested only 10 deep

Test 6.6.6.2-6 SQRT is OK

Test 6.6.6.2-7 ARCTAN is OK

Test 6.6.6.2-8 EXP is OK

Test 6.6.6.2-9 SIN and COS are OK

Test 6.6.6.2-10 LN is OK

Test 6.7.2.2-4 DIV is OK -- MOD returns remainder

Test 6.8.3.5-2 impossible branch of CASE not detected

Test 6.8.3.5-8 >= 256 CASES allowed

Test 6.8.3.9-18 FOR index is just bumped along without checking

Test 6.8.3.9-20 >= 15 nested FORs allowed

Test 6.8.3.10-7 >= 15 nested WITHs allowed

Test 6.8.4-10 output is not flushed at end of job

Test 6.9.4-14 recursive I/O allowed

Extension Tests

Test 6.8.3.5-14 'OTHERWISE' extension not implemented

DEC VAX 11/780

VAX 11 Pascal Validation Report

Pascal Processor Identification

Computer: VAX 11/780
Processor: VAX 11 Pascal V1.0-1

Test Conditions

Time: 1980 01 21
Test runs carried out by S. Matwin and B. Silverman
Test annotation and analysis by S. Matwin
Validation Suite version: 2.2

Conformance Tests

Number of tests passed: 127
Number of tests failed: 12, 8 basic causes

Details of failed tests:

Test 6.4.3.3-1 shows that empty record is not implemented.
Test 6.4.3.3-4 shows that the processor does not allow tag field redefinition
Tests 6.4.3.5-1 and 6.5.1-1 show that the function EXP does not pass accuracy test
Test 6.8.3.5-4 shows that <u>case</u> label range is limited to 1000
Test 6.8.3.9-7 shows that MAXINT is too big as an extreme value in a <u>for</u> statement, leads to overflow
Test 6.8.4-3, 6.9.4-4, 6.9.4-7, and 6.9.5-1 fail with a component of a packed structure as an actual variable parameter. This will happen in any compiler, written in Pascal, as the parameters of READ will be variable. On the other hand the Standard prohibits 'the use of components of variables of any packed type as actual variable parameters'
Test 6.9.4-15 shows that WRITE without the file parameter refers to a locally defined file

Deviance Tests

Number of deviations correctly detected: 67
Number of tests not detecting erroneous deviations: 24
(6 basic causes)

Details of deviations not detected:

Test 6.1.2-1 shows that the reserved word <u>nil</u> may be redefined
Test 6.1.5-6 shows that the processor allows small letter 'e' as an exponent indicator (which is sometimes claimed to be an extension)
Tests 6.2.2-4 and 6.3-6 show that in some circumstances the processor does not detect the use of an identifier prior to its definition

Tests 6.4.5-2 thru 6.4.5-5 and 6.4.5-13 show that the processor requires the compatibility of the types of formal and actual parameters, rather than type identity

Test 6.6.2-5 shows that the processor does not check the occurrence of at least one assignment to the function name in the function block

Tests 6.8.2.4-2 thru 6.8.2.4-4 show that the processor allows jumps between branches of an <u>if</u> and a <u>case</u> statement

Tests 6.8.3.9-2 thru 6.8.3.9-5, 6.8.3.9-13 thru 6.8.3.9-16 and 6.8.3.9-19 show that the processor omits some restrictions imposed on a <u>for</u> statement. The processor prohibits neither the assignment to the control variable nor the use of that variable after the completion of the loop. Other deviations of that class are

- control variable can be a formal parameter or a global variable
- reading into a control variable is allowed
- non-local control variable combined with recursion leads to an infinitely looping program

<u>Error Handling</u>

Number of errors correctly detected: 13
Number of errors not detected: 31

<u>Details of errors not detected</u>

Tests 6.2.1-7 and 6.4.3.3-12 show that the undefined values are not detected by the processor

Tests 6.4.3.3-5 thru 6.4.3.3-8 show that the existence of a particular variant in a record variable is not tested by the processor

Tests 6.4.6-4 thru 6.4.6-8, 6.5.3.2-1 and 6.7.2.4-1 show that the processor tests only the static compatibility, without checking the appropriateness of the actual value during run-time (unlike, e.g., Zurich Pascal-2 compiler)

Test 6.6.2-6 show that there is no dynamic checking of the fact whether the name is assigned to the function name

Tests 6.6.2.5-6 and 6.6.5.2-7 show that the parameter called by value can be changed inside the procedure in case of a buffer variable

Tests 6.6.5-3 and 6.6.5-4 show that the procedure DISPOSE does not check correctness of its parameter

Tests 6.6.5.3-5 and 6.6.5.3-6 show that both an actual variable parameter and an element of a record-variable-list of a <u>with</u> statement can be referred to by a pointer parameter of DISPOSE

Tests 6.6.5.3-7 thru 6.6.5.3-9 show that the restrictions on the variable, created by the second form of NEW, are not implemented

Tests 6.6.6-4 and 6.6.6-5 show that SUCC and PRED can produce values from beyond the enumeration type

Test 6.6.6.4-7 shows that the function CHR does not check the correctness of its parameter

Tests 6.8.3.5-5 and 6.8.3.6-6 show that there is no dynamic checking of the value of the <u>case</u> selector

Test 6.8.3.9-17 shows that two nested <u>for</u> statements can use the same control variable

<u>Implementation defined</u>

Number of tests run: 16
Number of tests incorrectly handled: 1

<u>Details of the implementation-dependencies:</u>

Test 6.4.2.2-7 shows MAXINT to be 2147483647

Tests 6.4.3.4-2 and 6.4.3.4-4 show that <u>set of</u> CHAR is allowed, that the negative elements in a set are not allowed, and that elements must not exceed 255

Tests 6.6.6.1-1 fails because formal functions are implemented following the Revised Report rather than the Standard

Tests 6.7.2.3-2 and 6.7.2.3-3 show that Boolean expressions are fully evaluated

Tests 6.8.2.2-1 and 6.8.2.2-2 show that selection precedes evaluation in the binding order

Tests 6.9.4-5 and 6.9.4-11 show that the default fields are:

- 10 for integer
- 16 for Boolean
- 16 for real

Test 6.10-2 shows that REWRITE on the standard file OUTPUT is possible

Tests 6.11-1 thru 6.11-3 show that only alternate comment delimiters (and no other equivalent symbols) are permitted

<u>Quality Measurement</u>

Number of tests run: 23
Number of tests incorrectly handled: 1

<u>Details of results</u>

Tests 5.2.2-1 and 6.1.3-3 show that there is no other limit on the length of the identifiers than the length of the line, although only the first 15 characters are significant

Test 6.10-4 shows that in case of an unclosed comment the text is swallowed without any diagnostics

Tests 6.1.2-8 and 6.1.2-9 show that large type- and label-lists are allowed

Test 6.4.3.2-4 shows that INTEGER is not allowed as an index type

Test 6.4.3.3-9 shows that fields in a record are stored in the order of their appearance in the field list

Test 6.4.3.4-5 (Warshall's algorithm) took 129 milliseconds of CPU time

Tests 6.6.6.2-6 thru 6.6.6.2-10 were completed with some errors, requiring separate analysis

Test 6.7.2.2-4 shows that <u>div</u> and <u>mod</u> have been implemented consistently for negative operands: quotient = trunc(a/b), <u>mod</u> returns remainder of <u>div</u>

Test 6.8.3.5-2 shows that 'impossible' paths through <u>case</u> statements are not signalled by the processor

Test 6.8.3.5-8 shows that a large number of case labels is allowed

Test 6.8.3.9-18 shows that the value of the control variable after the completion of a <u>for</u> loop is in the range of its type (and is equal to the final value)

Tests 6.8.3.9-20 and 6.8.3.10-7 show that <u>for</u> and <u>with</u> statements can be nested to a depth exceeding 15

Test 6.9.4-10 shows that flushing of the buffer of the output file occurs at the end of the program

Test 6.9.4-14 shows that recursive I/O using the same file is not possible

Extensions

Number of tests run: 1

Test 6.8.3-14 shows that <u>otherwise</u> clause is implemented, although one statement (rather than a sequence of them) is permitted between <u>otherwise</u> and <u>end</u>

IBM 370

PASCAL VALIDATION SUITE REPORT

Pascal Processor Identification

Computer: IBM 370/158
Processor: Stony Brook Pascal/360
(Developed at SUNY Stony Brook
Dept. of Computer Science)
Release 3.2 CMS version

Test Conditions

Tester: Charles Hill (MTS Philips Labs)
(Member of original implementation team)
Date: March 1980
Validation Suite Version: 2.2

Principal Deviations:

- Files use fixed length records, even for text files.
- Compiler does not permit untagged variants
- No run-time checking of tags on access to variant records
- FOR loop control variables can be altered
- PACKED and non-PACKED structures are indistinguishable
- Compiler uses structural equivalence rather than name equivalence of types
- Syntax for specifying the types of the parameters of procedural/functional parameters differs from the standard
- DISPOSE is not implemented

Main Extensions

- Case labels may be a subrange
- OTHERWISE clause in CASE statement
- Linkage to FORTRAN or machine language programs
- External compilation with type checking across module boundaries

Problems with the Validation Suite

Some syntax errors and invalid tests were discovered in the test programs; these are documented later on. The following minor violations of the assumptions made by the skeleton were found:

- Test 6.9.4-12 has a comment that begins "{This ..." causing the skeleton to mistake this comment for a header.
- The header for 6.8.3.4-1 is missing a comma.
- The expected delimiter "999" did not appear in the

program file; the termination logic has to be altered slightly anyway.

- The "END." for test 6.6.1-7 does not begin in column 1.

Conformance Tests

Number of tests passed: 113
Number of invalid tests: 3
Number of tests failed: 22 (14 causes)
Number of irrelevant tests: 3
Number of tests detecting bugs in compiler: 6

Invalid tests

6.4.3.5-1 PTRTOI, meant as a type, declared as a variable.

6.6.3.1-1 contains an actual VAR parameter non-identical in type to the formal parameter. The compiler passed this test when the error was corrected.

6.9.4-7 TRUE is written in a field of 5; when read back, the program expects it to be written left justified, in contrast to the standard which says that values should be written right justified.

Irrelevant tests

6.1.3-2,6.4.2.2-6 Compiler uses upper case only.

6.6.6.5-1 not a test program.

Tests detecting bugs in compiler

6.2.2-3 When typing a pointer to a type NODE, the compiler uses a definition of NODE from an outer block rather than a new definition of NODE appearing later on in the same block.

6.4.3.3-3 causes a bad instruction to be generated.

6.4.5-1 produces an irrelevant error message relating to file assignment.

6.6.5.2-3 blew up on a RESET to an un-initialized internal file using Release 3.1. The test passes using Release 3.2.

6.7.2.4-3 blew up on the expression A * [] = [].

Details of Failed Tests

6.1.6-2 Labels compared for equality as strings rather than integers and thus labels "6" and "0006" are considered distinct.

6.2.1-6,6.6.3.2-1,6.6.3.3-1 Compiler expects at least one parameter in the program heading.

6.2.2-8 Compiler does not allow assignment to the value of a function within an inner block of that function.

6.4.2.2-2 The maximum cardinality of a subrange is restricted to the value of MAXINT; compiler gives a warning and runs correctly, but only because the subrange is subsequently treated as equivalent to type INTEGER.

6.4.3.3-1 Untagged variants are not permitted.

6.4.3.3-10 Case constants outside the tag field subrange are not allowed.

6.4.3.5-2,6.9.1-1 Implementation uses fixed length records, even for text files; an empty line thus results in a record of blanks, rather than a single line-marker character.

6.6.3.1-5,6.6.3.4-2 A different syntax is used for declaring the parameter types of formal procedure/function parameters - only the types of the parameters are expected.

6.6.6.2-3, which tests the real-valued standard arithmetic functions, failed on the accuracy tests for EXP and SQRT.

6.6.6.4-1 Compiler computes ORD(x) with respect to the declared subrange to which x belongs, rather than with respect to the underlying base type.

6.8.3.9-7 When using values near MAXINT in a FOR loop, compiler gave an INTEGER OVERFLOW run error.

6.9.4-4 The second width specifier for formatting reals is not implemented.

6.9.4-6 The width specifier for strings must be a constant in the current implementation.

Deviance

Number of tests passed: 54
Number of tests showing deviance: 34 (17 causes)
Number of tests failed: 5
Number of tests detecting bugs: 3

Details of tests showing deviance

6.1.7-5,6.9.4-12 because PACKED and UNPACKED structures are treated as equivalent; i.e., the compiler makes no distinction between the two even for storage requirements.

6.1.7-6,6.4.3.2-5 Strings are compatible with all arrays of CHAR provided the lengths match.

6.2.1-5 If an identifier is declared as a label no error is produced if it is not subsequently referenced in a GOTO.

6.2.2-4 Use of a type identifier is permitted according to its definition in an outer block despite its redefinition in an inner block.

6.3-2,3,4,5, 6.7.2.2-9 shows signed constants of inappropriate types (e.g. strings) are allowed.

6.4.3.3-11, which tries to assign a value to an empty field in a record, blows up during semantic analysis (PASS 2 of the compiler).

6.4.5-3 (and 6.4.5-13, which is identical), 6.4.5-4,5 fail because the compiler uses structural equivalence rather than name equivalence of types.

6.4.4-2 The compiler fails to flag references to a pointer variable that points to a record type that is never defined.

6.6.1-6 Shows that compiler does not catch the lack of a subsequent full declaration for a procedure declared to be FORWARD (the program is allowed to run, even though that routine is actually called!); this is a bug. This test, as supplied, contained a missing semicolon.

6.6.2-5 Compiler does not detect the lack of an assignment of a value to a function within the function block.

6.6.6.3.4 Integer arguments to TRUNC and ROUND are permitted. (Such arguments are coerced to real as they would be in any other instance where reals are expected).

6.8.2.4-2,3,4 show the compiler allows jumps into IF and ELSE parts, and into CASE branches.

6.8.3.5-10 Compiler allows real CASE labels with a corresponding REAL CASE selector; test executes correctly.

6.8.3.9-2,3,4,14,16, 6.8.3.9-9,19 Show that there are practically no restrictions on FOR loop control variables: they can be assigned to or read in within (or outside) the loop body, and declared in any block. However, altering control variables do not affect the number of loop iterations; an altered value is retained only throughout the iteration in which it is changed, since the compiler uses a hidden temporary variable as the true control variable.

6.9.4-9 Shows the compiler treats negative field widths just as positive field widths that are too small - it uses the smallest actual width possible.

6.10-1 OUTPUT is not required to be listed in the program heading when output is directed to that file in the program.

6.10-3 Shows OUTPUT can be redefined as a variable within the program block.

6.8.3.5-12 shows compiler allows ranges as case labels.

Tests showing bugs in compiler

6.4.3.3-11, 6.4.4-2, 6.6.1-6 (described above)

Tests showing extensions

6.8.3.5-12,13, 6.8.3.9-10 show ranges are allowed as case labels, and that this extension is implemented safely.

Tests failed

6.6.3.5-2, 6.6.3.6-2,3,4,5 all failed because the compiler expects a different syntax for declaring the parameter types of formal procedure/function parameters.

Comments on passed tests

6.1.5-4 Decimal point not followed by a digit in a real number flagged as an error, but the program is allowed to run because no ambiguity is present in the case tested by the program.

6.1.7-11 A null string is flagged, but the program is allowed to run with a blank substituted.

6.1.8-5 Nested comments are permitted if the alternate delimiter symbols are used.

6.9.4-8 When real format is used to output an integer, the error is flagged but the program is allowed to run.

Error handling tests

Number of tests passed: 25
Number of tests failed: 23
Number of invalid tests: 1

Details of failed tests

6.2.1-7 No error message is given when an undefined variable is used.

6.4.3.3-5,6 show no run-time check on tag values is performed when referencing variants.

6.4.3.3-7,8 failed because the compiler does not allow untagged variants.

6.4.6-7,8, 6.7.2.4-1 show the compiler does not complain when the value of the expression in a set assignment lies outside the subrange to which the variable belongs (but is within the underlying base type).

6.6.2-6 Shows no check is made whether a function receives a value.

6.6.5.2-2 No EOF error given. This test fails because the implementation uses fixed length records for text files, and thus short lines are padded with blanks.

6.6.5.2-6,7 No error is given if a file component variable is an actual parameter to a procedure that does I/O to the file and thus alters the file component.

6.6.5.3-3,4 fail because DISPOSE is not implemented; no check is made on the validity of its arguments. Similarly, 6.6.5.3-6 shows no error is given when a pointer used in selection of a WITH control variable is disposed.

6.6.5.3-5 would fail if the test program were valid; the parameter A should be a VAR parameter.

6.6.5.3-7,8 show that no error is given if a variable returned by NEW containing tagged variants is used in its entirety.

6.8.3.5-5,6 When the value of a case selector <> any of the labels, no error message is given.

6.8.3.9-5,6,17 show that a FOR loop control variable is accessible outside the loop. After normal execution of the loop, it has the final value of the range. No error is given for nested FOR loops using the same control variable; the program iterates the expected number of times.

Implementation defined tests

Number of tests run: 15
Number of tests detecting bugs: 1

Details of Implementation dependence

6.4.2.2-7 shows MAXINT = 2147483647.

6.4.3.4-2 shows sets of CHAR are allowed.

6.4.3.4-4 shows the maximum set cardinality > 1000.

6.6.6.1-1, in which ODD appears as an actual function parameter, does not compile. The real-valued arithmetic functions are the only standard functions able to be passed in this way.

6.6.6.2-11 ran to completion, but some inconsistencies occured (i.e., XMIN <> BETA**MINEXP).

6.7.2.3-2,3 show short circuit evaluation of expressions is performed.

6.8.2.2-1 shows selection is performed before evaluation in A[I] := SIDEEFFECT(I). By contrast, test 6.8.2.2-2 shows

evaluation occurs before selection in P@ := SIDEEFFECT(P).
6.9.4-5 shows 2 digit exponents in output of real numbers.
6.9.4-11 detected a bug in RELEASES 3.0, 3.1. It shows the default field widths to be:

integer: 12
boolean: 14
real: 9

in contrast to the User manual and earlier releases, in which these formats are 12, 6, 14, respectively. This bug has been repaired in RELEASE 3.2.
6.10-2 shows REWRITE(OUTPUT) is not allowed.
6.11-1 shows the alternate comment convention is allowed; the delimiters must be pairwise matched, thus allowing code sections to be commented out.
6.11-2,3 show equivalent symbols %, .=, GT, LT, GE, LE, NE, are not allowed. @ is used instead of the EBCDIC translation of up-arrow.

Quality tests

Number of tests run: 22
Number of tests detecting bugs in compiler: 6
Number of tests not performed: 1

5.2.2-1, 6.1.3-3 show identifiers are distinquished over their whole length, but the compiler gives no indication the programs do not conform (i.e., contain identifiers with > 8 character significance). The compiler permits identifiers of up to 256 characters.
6.1.8-4 Shows compiler gives no indication of unclosed comments.
6.2.1-8,9, 6.5.1-2, 6.6.1-7, 6.8.3.9-20, 6.8.3.10-7 show a large number of label and type declarations, deeply nested (>15 levels) procedures, FOR loops, and WITH statements are permitted. However, test 6.8.3.5-8, which contains a heavily populated CASE statement, caused a compile time data structure to overflow at case 152.
6.7.2.2-4 shows DIV and MOD are implemented consistently, and that MOD yields the remainder of DIV.
6.9.4-10 shows that the output buffer is flushed at the end of the program.
6.8.3.5-2 shows the compiler does not detect that a case label, while contained in the underlying type, lies outside the subrange to which the selector belongs.
6.4.3.3.9 shows the ordering of the representation of variant fields is the same as the order of declaration.
6.6.6.2-6,7,8,9,10, which test the standard real-valued arithmetic functions, gave a mean relative error between E-06 and and E-07 in the interval tests. The special argument tests gave fairly good results. Most identity tests gave zero, as required; those that did not were within E-06 relative to the arguments.
6.8.3.9-18 shows the value of a FOR statement control variable after normal termination of the loop is the specified upper limit.
6.9.4-14 shows "recursive" I/O is allowed.

Test not performed

6.4.3.4-5 could not be run because timing is currently not implemented in the CMS version.

Tests demonstrating compiler bugs

6.4.3.2-4 shows compiler accepts an array with an index type of INTEGER, but the resulting program does not run correctly.
6.6.6.2-6,7,8,9,10 all crashed at run-time using Release 3.1. The bug has been fixed in Release 3.2.

Extensions

Number of tests run: 1

Test 6.8.3.5-14 did not compile; the compiler supports the OTHERWISE extension to the CASE statement but OTHERWISE <statement> replaces END rather than preceding it as in the proposed standard extension.

Univac 1100

PASCAL VALIDIATION SUITE REPORT

Authored by:
I.E. Johnson, E.N. Miya, S.K. Skedzieleweski

Pascal Processor Identification

Computer: Univac 1100/81

Processor: University of Wisconsin Pascal version 3.0 release A

Test Conditions

Testers: I.E. Johnson, E.N. Miya.

Date: April 1980

Validation Suite Version: 2.2

General Introduction to the UW Implementation

The UW Pascal compiler has been developed by Prof. Charles N. Fischer. The first work was done using the P4 compiler from Trondheim, then the NOSC Pascal compiler written by Mike Ball was used, and now all development is done using the UW Pascal compiler.

There are two UW Pascal compilers; one produces relocatable code and has external compilation features, while the other is a "load-and-go" compiler, which is cheaper for small programs. Most tests were run on the "load-and-go" version. Both compilers are 1-pass and do local, but not global optimization. The UW compiler is tenacious and will try to execute a program containing compile-time errors. This causes problems when running the Validation Suite, since programs that are designed to fail at compile time will appear to have executed.

Conformance Tests

Number of Tests Passed: 123

Number of Tests Failed: 16

Details of Failed Tests

Test 6.4.3.5-1 failed on the declaration of an external file of pointers (only internal files of pointers are permitted).

Tests 6.4.3.5-2, 6.4.3.5-3 and 6.9.1-1 failed due to an operating system "feature" which returns extra blanks at the end of a line. This problem affects EOLN detection.

Test 6.5.1-1 failed because the implementation prohibits files that contain files.

Tests 6.6.3.1-5 and 6.6.3.4-2 failed because the current version of this implementation prohibits passing standard functions and procedures as parameters.

Test 6.6.5.3-1 failed to assign an already locked tag field in a variant record, but the standard disallows such an assignment! (Error in test?)

Test 6.6.5.4-1 failed to pack because of a subscript out of range. MACC notified.

Test 6.6.6.2-3 failed a nine-digit exp comparison. Univac uses 8 digit floating point.

Test 6.6.6.5-2 failed test of ODD function (error with negative numbers).

Test 6.8.2.4-1 failed because non-local GOTO statements are not allowed by this implementation.

Test 6.8.3.4-1 failed to compile the "dangling else" statement, giving an erroneous syntax error.

Tests 6.9.4-1 and 6.9.4-4 failed do unrecoverable I/O error. Problem referred to MACC.

Test 6.9.4-7 failed to write boolean correctly. UW right-justifies each boolean in its field; the proposed ISO standard requires left-justification.

Extensions

Number of Tests Run: 1

Details of Tests

Test 6.8.3.5-14 shows that an OTHERWISE clause has been implemented in the case stetement.

Deviance Tests

Number of Deviations Correctly Handled: 77

Number of Deviations Incorrectly Handled: 14

Number of Tests Showing True Extensions: 2

Details of Extensions

Test 6.1.5-6 shows that a lower case e may be used in real numbers.

The research described in this paper was carried out at the Jet Propulsion Laboratory, California Institute of Technology, under NASA Contract NAS7-100.

Test 6.1.7-11 shows that a null string is accepted by this implementation.

Details of Incorrect Deviations

Tests 6.2.2-4, 6.3-6, 6.4.1-3 show errors in name scope. Global values of constants are used even though a local definition follows; this should cause a compile-time error.

Tests 6.4.5-3, 6.4.5-5 and 6.4.5-13 show that the implementation considers types that resolve to the same type to be "equivalent" and can be passed interchangeably to a procedure.

Test 6.6.2-5 shows a function declaration without an assignment to the function identifier.

Test 6.8.3.9-4 the for-loop control variable can be modified by a procedure called within the loop. No error found by implementation.

Tests 6.8.3.9-9, 6.8.3.9-13 and 6.8.3.9-14 show that a non-local variable can be used as a for-loop control variable.

Test 6.9.4-9 shows that a negative field width parameter in a write statement is accepted. It is mapped to zero.

Test 6.10-1 shows that the implementation substitutes the default file OUTPUT in the program header. No error message.

Test 6.10-4 shows that the implementation substitutes the existence of the program statement. We know that the compiler searched first but found source text (error correction).

Tests 6.1.8-5 and 6.6.3.1-4 appear to execute; this occured after the error corrector made the obvious changes.

Error Handling

Number of Errors Correctly Detected: 29

Number of Error Not Detected: 17

Details of Errors Not Detected

Tests 6.2.1-7, 6.4.3.3-6, 6.4.3.3-7, 6.4.3.3-8 and 6.4.3.3-12 show that the use of an uninitialized variable is not detected. Variant record fields are not invalidated when the tag changes. 6.4.3.3-12 incorrectly printed "PASS" when it should have printed "ERROR NOT DETECTED"

Test 6.6.2-6 shows the implementation does not detect that a function identifier has not been assigned a value within the function. The function should be undefined. The quality of the test could be improved by writing the value of CIRCLERADIUS.

Test 6.6.5.2-2 again runs into the EOLN problem.

Test 6.6.5.2-6 shows that the implementation fails to detect the change in value of a buffer variable when used as a global variable while its dereferenced value is passed as a value parameter. This sould not cause an error, and none was flagged. However, when the char was changed to a var parameter no error was detected, either.

Test 6.6.5.2-7 shows that the implementation fails to detect the change in a file pointer while the file pointer is in use in a with statement. This is noted in the implementation notes.

Test 6.6.5.3-5 shows the implementation failed to detect a dispose error; but again, the parameter was passed by value, not by reference! (Error in test)

Tests 6.6.5.3-7 and 6.6.5.3-9 show that the implementation failed to detect an error in the use of a pointer variable that was allocated with explicit tag values.

Tests 6.6.6.3-2 and 6.6.6.3-3 show that trunc or round of some real values. 2**36 does not cause a run time error or warning. In those cases, the value returned was negative. Error reported to MACC.

Tests 6.7.2.2-6 and 6.7.2.2-7 show that the implementation failed to detect integer overflow.

Tests 6.8.3.9-5 and 6.8.3.9-6 show that the implementation does not invalidate the value of a for-loop control variable after the execution of the for-loop. Value of the variable is equal to the last value in the loop. These tests could be improved by writing the value of m.

Implementation Defined

Number of Tests Run: 15

Number of Tests Incorrectly Handled: 0

Details of Implementation Definitions

Test 6.4.2.2-7 shows maxint equals 34359738367 (2**35-1).

Test 6.4.3.4-2 shows that a set of char is allowed.

Test 6.4.3.4-4 shows that 144 elements are allowed in a set, and that all ordinals must be >= 0 and <= 143.

Test 6.6.6.1-1 shows that neither declared nor standard functions and procedures (nor Assembler routines) be passed as parameters.

Test 6.6.6.2-11 details a number of machine characteristics such as

XMIN = Smallest Positive Floating Pt # = 1.4693679E-39

XMAX = Largest Positive Floating Pt # = 1.7014118E+38

Tests 6.7.2.3-2 and 6.7.2.3-3 show that boolean expressions are fully evaluated.

Tests 6.8.2.2-1 and 6.8.2.2-2 show that expressions are evaluated before variable selection in assignment statements.

Test 6.9.4-5 shows that the output format for the exponent part of real number is 2 digits. Test 6.9.4-11 shows that the implementation defined default values are:

integers	:	12 characters
boolean	:	12 characters
reals	:	12 characters

Test 6.10-2 shows that a rewrite to the standard file output is not permitted.

Tests 6.11-1, 6.11-2, and 6.11-3 show that the alternative comment delimiter symbols have been implemented; all other alternative symbols and notations have not been implemented. In addition, it is interesting that the compiler's error correction correctly substituted "[" for "(." and ":=" for "%=" as well as a number of faulty substitutions.

Quality Measurement

Number of Tests Runs: 23

Number of Tests Incorrectly Handled: 2

Results of Tests

Test 5.2.2-1 shows that the implementation was unable to distinguish very long identifiers (27 characters). Test 6.1.3-3 shows that the implementation uses up to 20 characters in distinguishing identifiers.

Test 6.1.8-4 shows that the implementation can detect the presence of possible unclosed comments (with a warning). Statements enclosed by such comments are not compiled.

Tests 6.2.1-8, 6.2.1-9 , and 6.5.1-2 show that large lists of declarations may be made in a block (Types, labels, and var).

Test 6.4.3.2-4 attempts to declare an array index range of "integer". The declaration seems to be accepted, but when the array is accessed (All[maxint]), an internal error occurs.

Test 6.4.3.3-9 shows that the variant fields of a record occupy the same space, using the declared order.

Test 6.4.3.4-5 (Warshall's algorithm) took 0.1356 seconds CPU time and 730 unpacked (36-bit) words on a Univac 1100/81.

Test 6.6.1-7 shows that procedures may not be nested to a depth greater than 7 due to implementation restriction. An anomolous error message occurred when the fifteenth procedure declaration was encountered; the message "Logical end of program reached before physical end" was issued at that time, but a message at the end of the program said "parse stack overflow".

Tests 6.6.6.2-6, 6.6.6.2-7, 6.6.6.2-8, 6.6.6.2-9, and 6.6.6.2-10 tested the sqrt, atan, exp, sin/cos, and ln functions. All tests ran, however, typical implmentation answers (which use the Univac standard assembler routines) were slightly smaller than Suite computed. Error typically occurred around the 8th digit (Univac floating-point precision limit).

Test 6.7.2.2-4 The inscrutable message "inconsistent division into negative operands" appears. We think it means that I MOD 2 is NOT equal to I - I div 2 * 2. Problem reported to MACC.

Test 6.8.3.5-2 shows that case constants must be in the same range as the case-index.

Test 6.8.3.5-8 shows that a very large case statement is not permissible (>=256 selections). A semantic stack overflow occurred after 109 labels.

Test 6.8.3.5-18 shows the undefined state is the previous state at the end of the for-loop. The range is checked.

Test 6.8.3.9-20 shows for-loops may be nested to a depth of 6.

Test 6.8.3.10-7 shows with-loops may be nested to a depth of 7.

Test 6.9.4-10 shows that the output buffer is flushed at the end of a program.

Test 6.9.4-14 shows that recursive I/O is permitted using the same file.

Concluding Comments

The general breakdown of errors is as follows:

I/O

These problems are intimately tied to the EXEC 1100 operating system and its penchant to pad blanks on the end of a line. There is no plan to try to correct this problem. Does an external file of pointers make sense!

Changes in the standard

Jensen and Wirth (second edition) was used as the standard for development of this compiler. Since there are discrepencies between it and the ISO proposed standard, several deviations occured. The compiler will be brought into conformance on most of these errors when some standard is adopted.

Restrictions

Some restrictions will be kept, even after a standard is adopted. GOTO's out of procedures will probably never be implemented, but STOP and ABORT statements have been added to the language to alleviate the problem.

Bugs

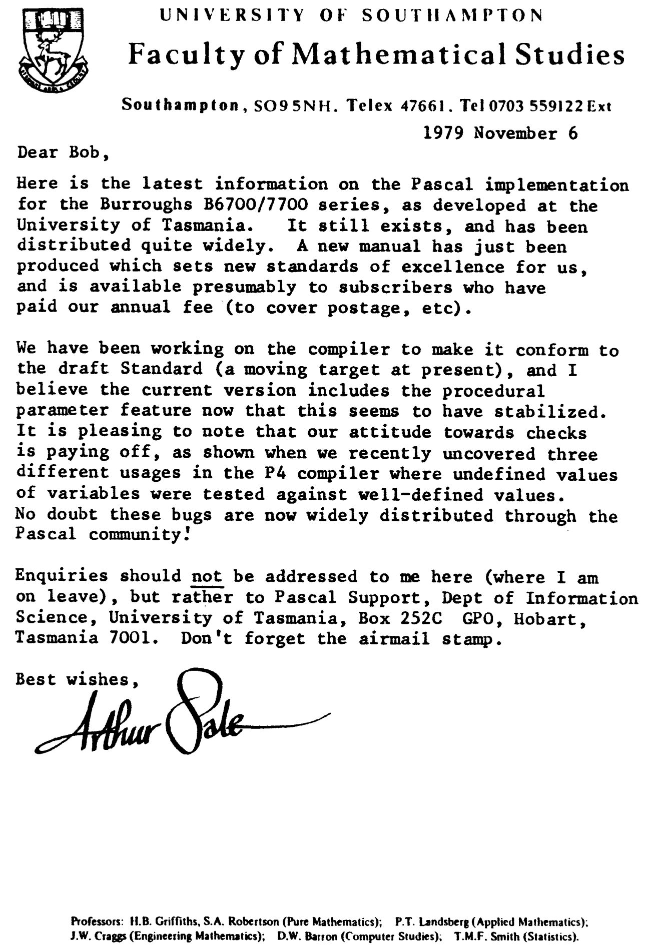
Several previously unknown bugs were found by running the validation suite. Professor Fischer has been notified, and corrections should be included in the next release of the compilers.

One area that should be emphasized is the clarity of the diagnostics produced by the compiler. All diagnostics are self-explanatory, even to the extent of saying "NOT YOUR FAULT" when an internal compiler error is detected. A complete scalar walk-back is produced whenever a fatal error occurs. The compiler attempts error correction and generally does a very good job of getting the program into execution.

The relocatable compiler has extensive external compilation features. A program compiled using these facilities receives the same compile-time diagnostics as if it were compiled in one piece.

Machine-dependent Implementations

Burroughs B6700/7700 (Tasmania)



UNIVERSITY OF SOUTHAMPTON

Faculty of Mathematical Studies

Southampton, SO9 5NH. Telex 47661. Tel 0703 559122 Ext

1979 November 6

Dear Bob,

Here is the latest information on the Pascal implementation for the Burroughs B6700/7700 series, as developed at the University of Tasmania. It still exists, and has been distributed quite widely. A new manual has just been produced which sets new standards of excellence for us, and is available presumably to subscribers who have paid our annual fee (to cover postage, etc).

We have been working on the compiler to make it conform to the draft Standard (a moving target at present), and I believe the current version includes the procedural parameter feature now that this seems to have stabilized. It is pleasing to note that our attitude towards checks is paying off, as shown when we recently uncovered three different usages in the P4 compiler where undefined values of variables were tested against well-defined values. No doubt these bugs are now widely distributed through the Pascal community!

Enquiries should not be addressed to me here (where I am on leave), but rather to Pascal Support, Dept of Information Science, University of Tasmania, Box 252C GPO, Hobart, Tasmania 7001. Don't forget the airmail stamp.

Best wishes,

Arthur Sale

Professors: H.B. Griffiths, S.A. Robertson (Pure Mathematics); P.T. Landsberg (Applied Mathematics); J.W. Craggs (Engineering Mathematics); D.W. Barron (Computer Studies); T.M.F. Smith (Statistics).

The University of Tasmania

Postal Address: Box 252C, G.P.O., Hobart, Tasmania, Australia 7001
Telephone: 23 0561. Cables 'Tasuni' Telex: 58150 UNTAS

IN REPLY PLEASE QUOTE:
FILE NO.
IF TELEPHONING OR CALLING
ASK FOR

15th April, 1980

Mr. R. Shaw,
Digital Equipment Corp.,
5775 Peachtree-Dunwoody Road,
Atlanta, Georgia.
U.S.A.

Dear Rick,

I have recently updated the B6700/7700 Pascal compiler to level 3.0.001. This compiler conforms to the Working Draft Standard, as published in Pascal News #14, fairly well. A copy of the updated Pascal Validation Suite Report concerning this compiler is enclosed.

We are in the process of distributing this compiler to all those installations which are currently using our Pascal system. The distribution should be complete by the time you receive/publish this letter.

We are also producing an updated Pascal Reference Manual to reflect the new compiler. The manual has just gone to the printers and we will distribute copies to users of our Pascal System when it returns. Allow a month or so.

Enclosed is an updated checklist describing the new compiler.

Yours sincerely,

Roy

Roy A. Freak,
Information Science Department

CHECKLIST

Burroughs B6700/B7700 (Tasmania)

0. DATE/VERSION April 1980 Version 3.0.001

1. IMPLEMENTOR/DISTRIBUTOR/MAINTAINER

   R.A. Freak & A.H.J. Sale;

   Pascal Support,
   Department of Information Science,
   University of Tasmania,
   Box 252C, GPO.,
   HOBART, Tasmania 7001
   Australia.

   phone (002) 230561 ext 435

2. MACHINE Burroughs Model III B6700, B7700

3. SYSTEM CONFIGURATION

   Burroughs MCP version II.8 (and later versions). Minimal system to operate is not known, but there is not likely to be any B6700 that small. Storage demands are low and little else is critical.

4. DISTRIBUTION

   Usually supplied on a 9-track PE tape but other forms on both 7 and 9-track tapes are available. An annual fee of $A100 is charged to cover mailing (air mail), processing and maintenance.

5. DOCUMENTATION Available documentation:

   R80-4: Pascal Reference Manual (similar to Burroughs Algol Manual)

   A Pascal language card

   A Pascal System card

   Pascal Validation Suite Report for B6700/B7700 Pascal.

6. MAINTENANCE

   To be maintained for teaching within the university as well as larger aims. Reported bugs will be fixed as soon as possible, with patch notices being sent to users. Duration of support not yet determined; several other developments are pending. Each installation is issued with a supply of FTR-forms similar to those used by Burroughs for use in corresponding with us, and we will attempt to do a professional job in maintaining the system.

The compiler has been stable in code for some time, reflecting its basic integrity. However, new features are added from time to time, and notified to users as patches or as a new version release. The department accepts FTR notices and will attempt to fix those which warrant such attention. Some modifications have taken place as a result of user feedback. The compiler was especially designed not to generate dangerous code to the MCP, and no system crashes have been attributed to it since the first few months of testing, 3 years ago, and then only three.

7. STANDARD

The compiler conforms fairly well to the Pascal Standard as published in Pascal News #14. We intend to update the compiler when a Pascal standard is accepted by ISO. The compiler performs better than most during testing by the Pascal Validation Suite. Briefly, the following restrictions and extensions apply:

Restrictions: Program heading; reserved word program is synomymous with procedure; file parameters are ignored after program heading.

Extensions: otherwise in case statement. Various reserved words, character set transliterations. Burroughs comment facility. File attributes in declaration. Format declarations and record oriented i/o available. Extensive Burroughs-compatible compiler options (Pascal control comment option mode not implemented). Ability to link in externally compiled subprograms.

8. MEASUREMENT

Compiles about 20% slower than Fortran or Algol, but in about 2/3 their space (for test programs about 4-5K words on average instead of 8-10K). Elapsed compilation times similar, though Pascal slower. Speed should be improved by eventual tuning.

Executes at the same speed as Fortran and Algol (code is similar and optimal) and takes generally longer elapsed residence time primarily due to MCP intervention to create new segments for record structures (not present in Fortran/Algol). Elapsed residence time about 20% greater than equivalent Algol.

9. RELIABILITY

Excellent. Since the early testing three years ago, no system crashes have been attributed to Pascal. The compiler is now in use at 28 sites throughout the world. It has been in use since 76/10 at University of Tasmania. First released to outside sites in 77/4.

10. DEVELOPMENT METHOD

Compiler which generates B6700/B7700 code files which are directly executed by the B6700 MCP. Written in B6700 Algol with two intrinsics written in Espol. Hand-coded using Pascal-P as a guide/model. All other paths offered much more difficulty due to special nature of machine/system. Person-month details not kept, but project proceeds in fits and starts as teaching and other activities intervene. Project has been undertaken largely by two people: Professor A.H.J. Sale and R.A. Freak with some support from T.S. McDermott.

11. LIBRARY SUPPORT

With release 3.0.001 of the Pascal compiler, the system has the ability to link in externally compiled subprograms written in another language. There is no facility available for separately compiling Pascal subprograms (not standard) so the only method of binding involves a Pascal host and a subprogram written in another language. The system contains an extended set of predefined mathematical functions.

CDC 6000 (Zuerich-Minnesota)

The new distributer for Pascal-6000 for East Asia and Australia is now:

Pascal Coordinator
University Computing Centre: H08
Universiity of Sydney
Sydney, N.S.W. 2006 Australia
Phone: 61-02-292 3491

Tony Gerber is finishing his studies and passed the responsibilities on to Brian Rowswell.

DEC LSI-11 (SofTech)

The UCSD version of Pascal is available from SofTech for $350 (includes operating system, compiler, editor, etc.). A FORTRAN that compiles to P-code is also available. For more information and processors that are supported, contact:

SofTech Microsystems
9494 Black Mountain Road
San Diego, California 92126

DEC VAX 11/780

UNIVERSITY OF WASHINGTON
DEPARTMENT OF COMPUTER SCIENCE

VAX-11 Pascal Compiler for the UNIX/32V Operating System

The Pascal compiler for the Digital Equipment VAX-11 computer, VAX-11 Pascal, has recently been modified to execute under the UNIX/32V operating system, version 1. The compiler, VAX-11 Pascal/Unix, will be distributed by the University of Washington, Department of Computer Science (UW), on a sublicense basis, subject to the following conditions.

1. All right, title, and interest in VAX-11 Pascal/Unix are the property of Digital Equipment Corporation (DEC).

2. Requestors for VAX-11 Pascal/Unix must have a license for the VMS version of VAX-11 Pascal from DEC. An object code license is required for the VAX-11 Pascal/Unix object code, a source code license for the VAX-11 Pascal/Unix source code.

3. The VAX-11 Pascal/Unix system will be distributed for a copy charge of US $ 50.00, payable to the University of Washington. Distribution will be on magnetic tape provided by UW. Please send your request, together with a check or purchase order, to

   Department of Computer Science
   University of Washington
   Mail Stop FR-35
   Seattle, WA 98195

   Further information can be obtained by contacting

   Professor Hellmut Golde (206) 543-9264

4. Requestors must sign the sublicense agreement attached to this announcement and return it to UW with the order. Please use the proper site identification so that the VMS license can be verified.

5. UW welcomes comments, suggestions and bug reports from users. Although no regular maintenance will be provided by either DEC or UW, a best effort will be made by UW to correct bugs for subsequent releases of VAX-11 Pascal/Unix. Any updated versions will require an additional copy fee.

The VAX-11 Pascal/Unix compiler does not implement all features of VAX-11 Pascal. However, the VAX-11 Pascal manuals available from DEC are sufficient to use VAX-11 Pascal/Unix. The following features are not currently supported by VAX-11 Pascal/Unix:

1. Value initialization.

2. %Include directive.

3. Calls to VMS library routines and system services. However, calls to the C library and Unix services are available.

4. The VMS debugger, and hence the DEBUG option. However, users may use the Unix absolute interactive debugger, adb(1).

5. The library functions/procedures DATE, TIME, and CLOCK.

6. Standard functions/procedures as procedure parameters.

In addition, a few restrictions are imposed under VAX-11 Pascal/Unix, as follows:

1. Since procedure linking is done by the Unix loader, all procedure names on nesting level 1 (main program level) and all external procedure names must differ in their first 7 characters. These names should not contain the character '$'.

2. The command language interface is different to conform with Unix.

3. Only standard Unix sequential files are supported. Hence the OPEN statement is limited to the form

   ```
   OPEN(<file variable>,<unix file name>,<file history>)
   ```

   The specifications of <record access mode>, <record type>, and <carriage control> are ignored. Also, FORTRAN type carriage control is not available. The VMS procedure FIND has not been implemented.

Beyond these restrictions, every effort has been made to make the two compilers compatible. There are some minor differences in expressions using library procedures and in input-output conversions, due to different algorithms.

Hewlett Packard HP 1000

Hewlett Packard now distributes a version of Pascal for their HP 1000 system. For details, contact a sales office.

IBM Series/1 (Massey U.)

IBM Series/1 Pascal

Pascal has been implemented at Massey University, Palmerston North, New Zealand for the IBM Series/1.

Hardware Requirements

Ability to support a 64K byte user partition using the R.P.S. operating system.

Major Restrictions

1. Files may not be declared. Four standard files are made available. These may be used as input or output files or (non standardly) as direct I/O files.

2. Some standard functions are not implemented - in particular the mathematical functions SIN, COS etc. However, selected functions may easily be implemented if required.

3. Limited to 16 bit sets, although some built in routines to handle 48 bit sets are available.

Structure

The compiler is based on the P4 portable Pascal compiler written by:

Authors:	Urs Ammann, Kesav Nori and Christian Jacobi
Address:	Institut fuer Informatik Eidg. Technische Hochschule Ch-8096 Zuerich.

It runs in two passes, (production of the P4 code and conversion of the P4 code to Series/1 code), and employs several storage overlays (not overlays as implemented in R.P.S.). All of the compiler, except the special environment (small assembler program) in which it runs, is written in Pascal. It can compile the main body of the first pass (3700+ lines of Pascal) in about ten minutes.

Availability

The compiling system will be made available to any non-profit organisation, for the cost of the distribution, from:

Computer Centre
Massey University
Palmerston North
New Zealand.

Support

Although no support for the system can be provided by the Computer Centre, rough implementation notes and advice are available from the author:

N. S. James
Computing Centre
University of Otago
P.O. Box 56
Dunedin
New Zealand.

16 January 1980

IBM 370 (StonyBrook)

From the release note accompanying Release 3.0 :

"....... Release 3.0 of the Stony Brook Pascal/370 compiler completes the implementation of Pascal files (for the production version), as well as correcting a few errors reported in Release 2. All further maintenance will be relative to Release 3.0, so it should be installed immediately. If you have presently a Release 2 or Release 1 distriibution tape, please return it to:

Ms. Patricia Merson
Department of Computer Science
SUNY at Stony Brook
Stony Brook, New York 11794

"...... Fairly detailed internal documentation for Pass 2 and Pass 3 of the Stony Brook compiler is now available on request from Ms. Merson. If you plan to perform any modifications of the compiler itself, you should obtain these documents. Pass 1 internal documentation has not yet been produced. ......"

{ Machine-dependent details concerning internal versus external files follows.}

IBM 370, 303x, 43xx (IBM) IBM PASCAL/VS

Pascal/VS is a compiler for a superset of the proposed ISO standard Pascal language, operating under OS/VS1, OS/VS2, and VM/CMS. The compiler was designed with the objective of producing reliable and efficient code for production applications. Pascal/VS is an Extended Support IUP (Installed User Program), program number 5796-PNQ.

The following information was supplied by David Pickens, IBM Corporation.

VERSION/DATE

Release 1.0, June 1980

DISTRIBUTOR and MAINTAINER

IBM Corporation

IMPLEMENTORS

Pascal/VS was implemented by J. David Pickens and Larry B. Weber at the IBM Santa Teresa Laboratory in San Jose, California. Others worked on the project for short periods of time. The comments and suggestions of internal users throughout IBM have had a significant influence in shaping the final product.

MACHINE and SYSTEM CONFIGURATION

Pascal/VS runs on System/370 including all models of the 370, 303x and 43xx computers providing one of the following operating system environments:

VM/CMS

OS/VS2 (MVS) TSO

OS/VS2 (MVS) Batch

OS/VS1 Batch

Under CMS, Pascal/VS requires a virtual machine of 768K to compile a program. Execution of a compiled program can be performed in a 256K CMS machine.

The compiler requires a 512K region for compilation under OS/VS2 and OS/VS1. A compiled and link-edited program can execute in a 128K region.

DISTRIBUTION

The compiler and documentation may be ordered through a local IBM data processing branch office.

The basic material of the order consists of one copy each of the Pascal/VS Language Reference Manual (SH20-6168) and the Pascal/VS Programmer's Guide (SH20-6162). The machine-readable material consists of source code, program load modules, and catalogued procedures. When ordering the basic material, specify one of the following numbers

Specify Number	Track Density	Description	User/ Volume Requirements
9029	9/1600	Mag tape	None/DTR
9031	9/6250	Mag tape	None/DTR

Monthly charges for this licensed Installed User Program will not be waived. The designated machine type is System/370.

Type	Program Number/ AAS	Monthly Charge
5796	PNQ	$235.00 (in the USA)

Monthly charges shown above are provided for information and are subject to change in accordance with the terms of the Agreement for IBM Licensed Programs (Z120-2800).

DOCUMENTATION

The Pascal/VS documentation consists of:

Document Name	Order Number	Price
Pascal/VS Language Reference (164pp)	SH20-6168	$14.50
Pascal/VS Programmer's Guide (144pp)	SH20-6162	$12.50
Pascal/VS Reference Summary (16pp)	GX20-2365	no charge
Pascal/VS Availability Notice	G320-6387	no charge

The Reference manual describes the Pascal/VS language. The Programmer's Guide describes how to use the compiler in the OS/VS1, OS/VS2 and VM/CMS environments.

The documentation may be ordered through your local IBM branch office.

MAINTENANCE

IBM will service this product through one central location known as Central Service.

Central Service will be provided until otherwise notified. Users will be given a minimum of six months notice prior to the discontinuance of Central Service.

During the Central Service period, IBM, through the program sponsor(s) will, without additional charge, respond to an error in the current unaltered release of the compiler by issuing known error correction information to the customer reporting the problem and/or issuing corrected code or notice of availability of corrected code. However, IBM does not guarantee service results or represent or warrant that all errors will be corrected.

Any on-site program service or assistance will be provided at a charge.

Documentation concerning errors in the compiler may be submitted to:

IBM Corporation
555 Bailey Avenue
P.O. Box 50020
San Jose, California 95150
Attn: Larry B. Weber
M48/D25
Telephone: (408) 463-3159 or
Tieline: 8-543-3159

Marketing Sponsor

IBM Corporation
DPD, Western Region
3424 Wilshire Boulevard
Los Angeles, California 90010
Attn: Keith J. Warltier
Telephone: (213) 736-4645 or
Tieline: 8-285-4645

STANDARD

Pascal/VS supports the currently proposed International Standards Organization (ISO) standard and includes many important extensions. Among the extensions are:

Entry and external procedures to provide separate compilation

"Include" facility to provide a means for inserting source from a library into a program

Varying length character strings, string concatenation, and string handling functions

Static variables

The "ASSERT" statement

"LEAVE" and "CONTINUE" statements for more flexible loop control

"OTHERWISE" clause on the CASE statement

Subranges permitted as CASE statement "labels"

Integer, real, and character constants may be expressed in hexadecimal

Various predeclared system-interface routines such as HALT, CLOCK, DATETIME, RETCODE, etc.

MEASUREMENTS

Under VM/CMS the compiler will compile a typical program of 1000 lines at the approximate rates shown below:

Host System	Rate of compilation
370/158	10,000 lines per minute
370/168	20,000 " " "
3033	40,000 " " "

If the compiler listing is suppressed, the performance improves by 20 to 25 per cent.

RELIABILITY

Prior to external release, the compiler was distributed to over 60 test sites within IBM. The first internal shipment of the compiler was in July of 1979. All errors reported prior to the release of the compiler have been corrected.

DEVELOPMENT METHOD

The compiler consists of two passes which run as two separate programs. The first pass is based on an extensively modified version of the Pascal P4 compiler (authored by Urs Ammann, Kesav Nori, and Christian Jacobi). The P4 compiler was re-targetted to produce U-code instead of P-code as an intermediate language. U-code is an enhanced version of P-code that was designed by Richard L. Sites and Daniel R. Perkins (Universal P-code Definition, U.C. San Diego, UCSD/CS-79/037, 1979). The compiler employs the error recovery algorithm described in A Concurrent Pascal Compiler for Minicomputers by Alfred C. Hartmann (Springer-Verlag, 1977).

The second pass of the compiler translates the U-code directly into an OS object deck. The translator performs local common subexpression elimination, local register optimization, dead store removal, removal of redundant checking code, removal of cascading jumps, and various peep-hole optimizations.

All but 5% of the execution library is written in Pascal/VS; the remainder is in assembler language. I/O and heap management is done by calls to Pascal procedures.

The compiler, written in Pascal/VS, is shipped with all run time checking enabled. The compiler eliminates unnecessary range checks by keeping track of the lower and upper bounds of expressions involving subrange variables. The checking code in the compiler costs only 7 to 10% in performance.

The development of Pascal/VS began in January, 1979. To bootstrap the compiler, an experimental Pascal compiler developed by Larry Weber was used; it was a one pass compiler written in PL/I (believe it or not!).

The first bootstrap was completed in June, 1979. Since that time, the compiler has been tested, enhanced, and modified to conform to the proposed ISO standard.

LIBRARY SUPPORT

Pascal/VS supports separate compilation of routines and uses standard OS linkage conventions. A Pascal/VS program may call routines written in FORTRAN, COBOL, and Assembler language.

DEBUGGER SUPPORT

Pascal/VS supports an interactive symbolic debugger which permits:

break points to be set

statement by statement walk-through of a procedure

variables to be displayed by name and in a form which correspond to their type (pointers, field qualifiers and subscripts are allowed).

IBM 3033 (Metropolitan Life)

IMPLEMENTATION CHECKLIST

0. Date 80/06/17

1. Implementor/Maintainer/Distributer
Taiwan Chang
Metropolitan Life Insurance Co.
20-Y
1 Madison Avenue
New York, New York 10010
(212) 578-7079

2. Machine/ System configuration 3033 VM/CMS

3. Distribution
Taiwan Chang
Metropolitan Life Insurance Co.
20-Y
1 Madison Avenue
New York, New York 10010
CMS tape, 1600 bpi

4. Documentation
Implementation guide, conversion guide

5. Maintenance
StonyBrook's OS Pascal Level III is not converted yet.

6. Standard
Converted from StonyBrook's OS Pascal

7. Measurements

8. Reliability
MIT okay, local okay

9. Development method
XPL implementation

10. Library support
CMS macros

Motorola 6800 (Dynasoft)

Dyna
soft
systems

P.O. BOX 51
WINDSOR JCT., N.S.
CANADA B0N 2V0
(902) 861-2202

Thank you for your inquiry about DYNASOFT PASCAL. I hope that this will answer most of your questions and help you decide if it will be a useful addition to your system.

DYNASOFT PASCAL was designed to make a practical subset of the PASCAL language available to the users of relatively small cassette-based 6800 and 6809 computers. Both versions occupy slightly less than 8K bytes and require at least 12K of continuous RAM beginning at $0020 to edit and compile programs of reasonable size. The compiler will compile itself in 32K, although the source code is not included in the package.

The 6800 version was designed for the SWTPC 6800 computer with the SWTBUG^{tm} monitor, but it can be adapted to run with most other monitors with minor patching. The 6809 version is completely self-contained with its own imbedded device drivers, and is independent of any particular monitor. Both versions include the compiler, p-code interpreter, and a line oriented text editor, and are priced at $35.00. They are supplied on a Kansas City Standard cassette in Motorola "S1" format at 300 baud, and come with a 32 page user's manual.

The 6800 version is also available in ROM, intended for use with the SWTBUG^{tm} monitor on the SWTPC MP-A2 processor board. It occupies the 8K block at $C000 and is supplied in four TMS2516 EPROM's. The price is $300.00. We do not keep a stock of blank ROM's, so please allow 8 weeks for processing.

All orders should include $3.00 for postage and handling. Payment can be made by postal money order, check, or VISA account in either Canadian or U.S. funds.

Thank you again for your interest.

Allan G. Jost

Allan G. Jost, Ph.D.

DYNASOFT PASCAL SUMMARY, RELEASE 1.0

DATA TYPES:

INTEGER (16 bit)

CHAR (8 bit)

BOOLEAN

ARRAY (one dimensional)

scalar (user defined)

subrange

pointer

ARITHMETIC AND LOGICAL OPERATORS:

+ - * DIV MOD AND OR NOT

RELATIONAL OPERATORS:

= <> < > <= >=

LANGUAGE FEATURES:

CONST

TYPE

VAR

PROCEDURE

FUNCTION

IF-THEN-ELSE

BEGIN-END

CASE-OF-OTHERWISE

FOR-TO/DOWNTO-DO

REPEAT-UNTIL

WHILE-DO

READ

WRITE

WRITELN

Machine-language subroutines with parameters

80 character identifiers (first 4 unique)

Absolute memory addressing using pointers

LINK to other programs

Full recursion

PREDEFINED PROCEDURES AND FUNCTIONS:

ODD SHL SHR FIND HALT LINK MOVL MOVR SETP

SUPERVISOR COMMANDS:

Load, Save, Edit, Compile, Go, Move, Quit

EDITOR COMMANDS:

New, Top, Bottom, Up, Down, Find, Print, Insert, Kill, Replace, Quit

Motorola 6800/68000 (T.H.E.)

Technische Hogeschool Eindhoven

Den Dolech 2
Postbus 513
5600 MB Eindhoven
Telefoon (040) 47 91 11
Telex 51163

To Andy Mickel,
editor of Pascal News

Uw kenmerk	Ons kenmerk	Datum	Doorkiesnummer
		19800319	

Onderwerp

Dear Andy,

Enclosed you find checklists of two Pascal implementations we made on Motorola microcomputers : an M 6800 and an XC 68000, which is the experimental version of the M68000.

The M6800 implementation has already been in operation for about 2 years now and during this period the system proved to be extremely reliable and stable. This system is informally known as the POMME system (Pascal on Motorola microcomputer equipment). The compiler generates a kind of P-code which is quite different from the P-codes of the portable P4-compiler and the UCSD-code. The compiler is not a P-compiler derivative but is written from scratch. The code generated by the compiler is interpreted without the intervenence of an optimizer, a linker or such. The interpreter is 3.5 Kbytes of machine code and the compiler 17.6 Kbytes of P-code. Depending on the scattering of files on floppy disk the compilation speed is betwean 400 and 600 lines per minute.

The language implemented contains the proposed ISO Pascal-standard as a subset. The only restriction is : files must be declared in the outerblock only (file parameters of procedures and functions are of course possible). The extensions include:

- a library facility (on source level)
- interfacing with assembly language routines

- absoiute address specification of variables (to allow memory-mapped I/O without the need of assembly code).
- subranges and OTHERWISE as labels in a case-statement, subranges also in the variant-part of records.
- if the program contains a record-type definition like

  ```
          complex = RECORD re, im: real END
  ```

  then the construct complex(x,y) is an expression of type complex provided x and y are of type real.
- the so-called "boundless" array parameters.
- in addition to AND and OR the short-circuited CAND and COR.
- random-access files.
- interactive I/O via files input and output

The compiler will always select the most compact representation of sets (up to 16 bytes) Hence sets of characters are possible. Furthermore a SET OF 0..7 requires only one byte and can beautifully be used to communicate with peripherals, due to the memory-mapped I/O.

If programs are run with runtime checks included then the detection of an error will result in a symbolic dump of the program's stack, including identifiers of variables and procedures, and linenumbers of the error and "current" procedure calls. Various errors not normally checked for will be detected in case the runtime checks are turned on, e.g. a student-proof method to check changes of a controlled variable in a for-statement.

In order to speed up some of the clerical tasks of the interpreter, some IC's were added to the processor. The processor board, however, is still compatible with the original Motorola EXORciser bus. The additions allow for a continuous check on stack overflow, a check which, when done in software, is time-consuming and/or difficult (the P4 and UCSD strategies are unsafe!).

The POMME system normally operates in a single-user environment with an EXORciser or EXORterm and a dual floppy disk drive. It is, however, possible to interconnect up to 6 of these systems to form a multi user system, sharing the disk space. The POMME system will then guarantee mutual exclusion on file access, on the basis of individual sectors.

One of the programs available on the POMME system is a cross-compiler for the XC 68000. This compiler (reals and files are not yet implemented) generates relocatable machine code which does not require an interpreter, runtime package or operating system to execute. The code is close to optimal and to achieve this the compiler does not consist of a single pass but is a 3-pass compiler. This process necessarily slows down compilation, mainly because all intermediate code is kept on a floppy disk. The output of the compiler need not be input to an assembler but is executable, position independent code.

Although I have written all software of the POMME system it is now maintained and distributed by

EPOS (Efficient Pascal Oriented Systems)
Generaal de Carislaan 60
5623 GL Eindhoven
The Netherlands
tel. 040 - 445552

Some sample programs were run for speed comparisons. Roughly speaking, the M6800 system compiles at about 4 times and executes at about twice the speed of UCSD-implementations on LSI-11 and Z-80. We feel this pretty impressive for a 1 MHertz 8 bit processor. The cross-compiler for the XC 68000 is much slower, it compiles at half the speed of LSI-11 and Z-80 UCSD. Execution times, however, are about equal to DEC-10, half the speed of a Burroughs B7700 and a quarter of the speed of CDC Cyber 175. Notice that the XC 68000 is only a prototype of the M68000 running at half the projected speed.

Finally it should be noted that a compiler for the M6809 along the lines of the XC 68000 implementation will be available soon.

Yours sincerely

JLA van de Snepscheut
Eindhoven University of Technology
Dept. of Mathematics
March 19, 1980

Checklist Motorola M6800 (POMME system)

date 1980, march 19

maintainer/distributor EPOS
Generaal de Carislaan 60
5623 GL Eindhoven (The Netherlands)

maintenance fully maintained

standard contains standard-Pascal as a subset

measurements roughly twice the speed of the UCSD-implementations on LSI-11 and Z-80; compilation even ~~faster~~ four times.

reliability 2 years in operation, very stable and reliable

library support source libraries in Pascal
linkage to assembly language routines

machine Motorola M6800

Checklist Motorola XC 68000

date 1980, march 19

maintainer/distributor EPOS
Generaal de Carislaan 60
5623 GL Eindhoven (The Netherlands)

maintenance fully maintained

standard contains standard-Pascal as a subset with the exception that reals en files are not yet implemented

measurements the XC68000 is a prototype of the M68000 running at half the projected speed, yet execution times are about equal to DEC-10.
cross-compilation time on a M6800 is about twice as long as compilation times of UCSD-Pascal on LSI-11 and Z 80.

reliability not much experience

library support source libraries in Pascal

machine Motorola XC 68000
cross-compilation on Motorola M6800 (POMME system)

Zilog Z-80 (MetaTech)

(See the checklist in issue #17 under Intel 8080/8085 (MetaTech))

Zilog Z-80 (Digital Marketing)

This compiler runs under CP/M and is a Pascal-P descendant. The price is $350.

Digital Marketing
2670 Cherry Lane
Walnut Creek, CA 994596

Zilog Z-80/ TRS-80 (People's Software)

nonprofit

computer information exchange, inc.

BOX 158, SAN LUIS REY CA 92068 (714) 757-4849

Bill McLalughlin, editor, pres., treas.
John Ingram, executive vice president
Dorcas Edge,vice president, secretary

TRS-80 COMPUTING
TRS-80 BULLETIN
(TRS-80 is Tandy Corp. trademark)

December 26, 1979

PRESS RELEASE:

TINY PASCAL COMPILER JUST $15

People's Software at nonprofit Computer Information Exchange is selling a tiny Pascal compiler for $15.

Written in Basic, People's Pascal I runs on any 16K TRS-80 Level II system. Compilers let computerists write fast, efficient machine code while working with a higher-level language. Pascal is the structured language everyone is talking about—and studying in college.

The People's Pascal I program development system comes on a tape with 14 programs, and 18 11x17" pages of documentation. Programs include editor/ compiler, interpreter, translator, run-time system and two demonstration programs.

People's Pascal I compiler produces P codes, which the translator converts to Z-80 code, the TRS-80 native language. The user is given the option of optimizing for either speed or memory efficiency. Programs written via People's Pascal I run three times faster than those in Level II Basic—graphics is eight times faster.

To produce object programs, the computerist must use the People's Pascal I programs, plus Tandy T-Bug. Use of Tandy editor/assembler is optional.

The People's Pascal I program development system, with editor/compiler and interpreter written in Basic, and its multiple parts, is not the ultimate in speed and simplicity of use.

People's Pascal II, at $23, is easier to use and faster operating. It is all one machine-language program. Programs written in Pascal II do not execute quite as fast as those in Pascal I because the system does not produce Z-80 object programs of the user's source program.

Both Pascal I and II compile user programs into P-codes. Both systems work in an interpretive mode, interpreting P-codes into Z-80 codes.

(more)

(PEOPLE'S PASCAL, add 1)

But Pascal I has a translator for creating Z-80 native-code programs, and Pascal II does not. In Pascal II, all user programs must be interpreted each time they are executed. Pascal II is still said to be four to eight times faster than Level II Basic.

Pascal I is only for 16K systems. Pascal II is for either 16K or 32K systems. Pascal I has UCSD-like turtle graphics. Pascal I requires line numbers in the user program, and Pascal II does not.

Dealer inquiries are invited. Computerists wishing to buy direct should include 50¢ for each tape ordered, and California residents should add 6 per cent tax ($.90 and $1.38, respectively, on Pascal I and II). Computer Information Exchange is at Box 158, San Luis Rey CA 92068.

Besides People's Pascal I and II, People's Pascal has three public-domain program tapes in Level II, and two in Level I, at $7.50 each (plus 50 cents postage-handling, CA residents add 45 cents tax). The public domain tapes have as many as 77 programs on them.

IMPLEMENTATION NOTES ONE PURPOSE COUPON

0. **DATE**

1. **IMPLEMENTOR/MAINTAINER/DISTRIBUTOR** *(* Give a person, address and phone number. *)*

2. **MACHINE/SYSTEM CONFIGURATION** *(* Any known limits on the configuration or support software required, e.g. operating system. *)*

3. **DISTRIBUTION** *(* Who to ask, how it comes, in what options, and at what price. *)*

4. **DOCUMENTATION** *(* What is available and where. *)*

5. **MAINTENANCE** *(* Is it unmaintained, fully maintained, etc? *)*

6. **STANDARD** *(* How does it measure up to standard Pascal? Is it a subset? Extended? How. *)*

7. **MEASUREMENTS** *(* Of its speed or space. *)*

8. **RELIABILITY** *(* Any information about field use or sites installed. *)*

9. **DEVELOPMENT METHOD** *(* How was it developed and what was it written in? *)*

10. **LIBRARY SUPPORT** *(* Any other support for compiler in the form of linkages to other languages, source libraries, etc. *)*

(FOLD HERE)

PLACE
POSTAGE
HERE

Bob Dietrich
M.S. 92-134
Tektronix, Inc.
P.O. Box 500
Beaverton, Oregon 97077
U.S.A.

(FOLD HERE)

NOTE: Pascal News publishes all the checklists it gets. Implementors should send us their checklists for their products so the thousands of committed Pascalers can judge them for their merit. Otherwise we must rely on rumors.

Please feel free to use additional sheets of paper.

IMPLEMENTATION NOTES ONE PURPOSE COUPON