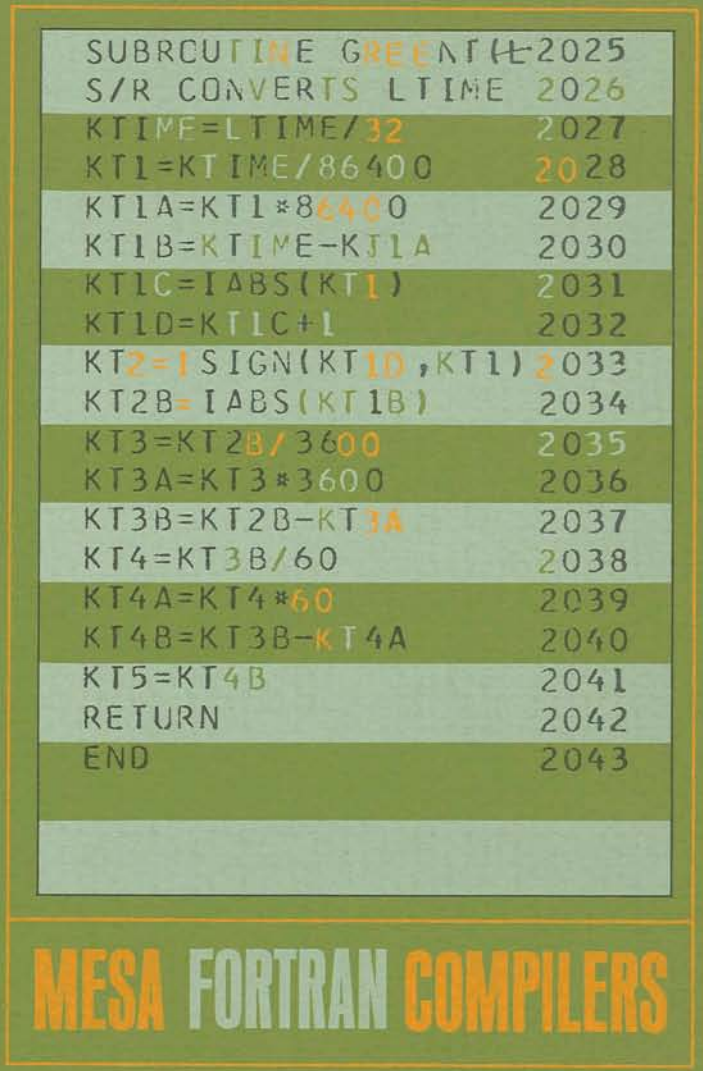

MESA FORTRAN COMPILERS

Successful compiler implementation as defined at Mesa

FORTRAN (formula translation) is a problem-oriented programming language closely allied to the expressions used in stating mathematical relationships. Engineers, scientists, and accountants have come to accept FORTRAN as the standard language used for avoiding time-consuming machine language programming techniques. So universal is the use of FORTRAN for programming mathematical and business problems that most computer systems feature this compiler as standard equipment. ■ FORTRAN saves both programmer and computer time during problem coding. Mesa FORTRAN compilers introduce advanced features that further reduce programmer effort and computer running time to a practical minimum while compiling an optimum object program. Mesa avoids the inefficient, short-range shortcuts of cookbook compiler implementation, wherein a FORTRAN model is prepared for a pseudo-computer and then varied to work in systems that may differ radically. The losses in efficiency and performance that accompany such implementation lead to significant hidden expenses in computer running time and programmer coding time. To reduce both short-range and long-range compiler costs, Mesa designs a special solution to hardware capabilities and requirements, programming assignments, and the client's need for speed, code optimization, and debugging aids. Efficient operation is the criterion that defines successful compiler implementation at Mesa; and by meeting its own high standards consistently, Mesa has become the industry leader in FORTRAN compiler development. ■

Mesa's custom-tailored FORTRAN compilers take maximum advantage of computer operating characteristics

Competition in the past few years has forced computer manufacturers to make many changes to provide faster and more compact computer systems. These changes have resulted in major advances in machine technology. Mesa has matched this increase in computer capability with equally advanced software. For instance, Mesa has implemented and extended FORTRAN II compiler using a total of only 2,260 instructions and constants and has designed a complete load-and-go FORTRAN IV for an 8k, 16-bit computer. A recently completed one-pass, 4k compiler demonstrated an internal processing speed in excess of 2,000 statements per minute. ■ Mesa has developed these new, compact compilers without sacrificing performance. These compilers generate object code as efficient as or better than that of their ponderous predecessors. Also, these faster compilers are more convenient for programmers to use; with fewer restrictions, they are easier to master and result in fewer errors. Features that add to the performance of these sophisticated compilers include: mixed-mode arithmetic, dynamic storage allocation, recursive subprogram calls, Hollerith and logical assignment statements, in-line assembly language capability, generalized subscripts and DO indexing, along with complete object code optimization. Mesa's achievement in improving computer software is based on the firm's individual approach to compiler implementation. In each case, the final product is more efficient and requires less memory space because it takes greater advantage of specialized features within the individual computer repertoire. ■

Advanced technical features and Mesa customer service combine to ensure efficient compiler operation

COMPACT COMPUTER CONFIGURATION. Mesa compilers are designed to operate on a minimum computer configuration including a paper tape reader-punch and typewriter or an on-line flexowriter. Additional input and output devices may be included or substituted. Several dozen library functions, such as SIN, EXP, SQRT, and LOG, may be made available to the user, with other functional relationships written by the programmer. A significant feature of Mesa compilers is the use of a data pool for all table storage. The size of the data pool is dependent on available memory and is automatically expandable for increased memory sizes. During compilation, all table areas are dynamically allocated within the data pool as required. This procedure eliminates fixed table limits, providing flexibility of operation and maximum utilization of available storage.

HIGH COMPILING SPEEDS.

■ 24-bit word, 4μs add time, 4k memory, extended one-pass FORTRAN II, program tracing, in-line assembly, dynamic storage allocation, recursive subroutine calls, internal compilation speed of 2,000 source lines per minute.

■ 28-bit word, 12μs add time, 4k memory, one-pass FORTRAN II, complete error checking, internal compilation speed of 750 source lines per minute.

■ 18-bit word, 4μs add time, 8k memory, ASA FORTRAN IV, chaining, data initialization, all I/O gear driven full speed.

■ 30-bit word, 10μs add time, ASA FORTRAN IV, program chaining, data initialization, integrated with real-time executive and I/O system, all I/O gear driven at full speed.

COMPLETE DEBUGGING AIDS. Mesa compilers feature complete error analysis at the source level. The statement in error is underlined, showing where the error occurred; and an error notice is appended, showing what the error was. A comprehensive, Mesa-designed, object-time debugging system—which, like all other features, may vary to meet specific requirements—can include a program for typewriter input of octal corrections, a memory type-out routine, a program for selective memory type-out routine, a program for selective memory clear, and a breakpoint type-in program. Other debugging aids available are symbolic output listing, an on-line program trace, and a multiple-format memory dump.

SOPHISTICATED CODE OPTIMIZATION. Optimizing features available include:

■ Elimination of common subexpressions within and across groups of statements (including subscripts, subexpressions containing array elements, and certain ungrouped and complement subexpressions).

■ Elimination of redundant index loads.

■ Minimization of sign parity operation by means of a sophisticated sign control algorithm.

■ Elimination of unnecessary load and store operations by means of extensive operand reordering.

■ Evaluation (based on DeMorgan's Laws) of logical expressions to eliminate redundant terms and avoid unnecessary interrogation.

■ Evaluation of constant subexpressions at compile time to produce constants in a proper mode for computation and for combination of constant subscripts with the array base address.

DOCUMENTATION. One of Mesa's first tasks is the writing of a User's Manual. This is a complete, professionally written statement of the FORTRAN dialect to be used, and it includes all information needed by a programmer to write programs. The User's Manual permits the client to begin FORTRAN coding even before the compiler exists, with complete confidence that the programs will be accepted by the compiler upon delivery. In addition to the User's Manual, Mesa prepares an Operating Manual (setup and troubleshooting instructions) and a complete set of the maintenance documentation developed during the implementation of the compiler (flow charts, narrative descriptions of internal subroutines, memory maps, file layouts, table layouts, statement listings, test decks, and the results of test deck runs).

TRAINING. The Mesa team maintains continuous liaison with the client's technical staff to ensure a smooth transition period following final acceptance testing. During this time, Mesa conducts a training course in compiler operation and maintenance for the client's programming staff.

Mesa's FORTRAN compilers are featured with many computer systems

Computer systems for which Mesa has designed and implemented FORTRAN compilers include: Advanced Scientific Instruments ASI-6020, ASI-6040; Bunker Ramo BR-340; Computer Control Company DDP-116, DDP-24, DDP-224; Philco CXPQ; Systems Engineering Laboratories SEL-810, SEL-840; UNIVAC 418 and UNIVAC 490. ■ Other computer systems for which Mesa has designed, implemented, or augmented similarly advanced compiler systems include: CDC-924, Hughes HCM-111, Honeywell H-300, GE 235, IBM 7090, IBM 7094, UNIVAC 1218, and UNIVAC CP-667.

Mesa's background in software implementation

Mesa Scientific Corporation, a subsidiary of Planning Research Corporation, is an industry leader in implementing FORTRAN compilers. Mesa has designed and implemented as many as 16 compilers simultaneously. Most of Mesa's compiler contracts are won as a result of favorable evaluation of both cost and technical factors in competitive bidding. Preeminence in this field of computer software is not, however, the result of narrow specialization. On the contrary, Mesa's FORTRAN capability is based on technical and management performance on a variety of programming and analysis contracts. ■ Mesa is one of the oldest computer consulting firms in the United States, and has grown since 1957 from a one-man operation to a company staffed by more than 180 professional, senior-level engineers, scientists, and programmers. The compilers offered by Mesa and Planning Research include APT, ATOLL, COBOL, FORTRAN, JOVIAL, PL/I, and STOL. In addition to compiler implementation, the technical services offered by Mesa's staff include systems engineering, digital equipment design, mathematical analysis, computer applications, scientific programming, commercial programming, real-time programming, and development and programming of computer software systems. ■ Throughout the growth of the firm, Mesa's management has demonstrated skill and astuteness in a variety of project areas. The company's stock in trade is superior technical talent, combining knowledge and practical experience. But consistent excellence in technical performance would be impossible without equal excellence in assigning project responsibility, establishing and maintaining schedules, establishing technical standards, and supervising the many details of budget, security, personnel, and contract administration. ■ Mesa has by steady growth of management and technical capabilities developed a general-purpose breadth of experience in many fields of software implementation. At the same time, by means of constant research and advancement, Mesa has achieved a specialist's knowledge of individual applications, such as the FORTRAN compiler.

Technical Summary

Mesa compiler development starts with a definition of the source language. This is normally one of the two ASA standard languages, with additions or deletions as specified by the customer. Additions available are endless; some popular ones consist of in-line symbolic assembly language, backward and forward indexing, mixed-mode arithmetic, special real-time features, a variety of data handling statements, and various logical operators. ■ Important features:

MEMORY CORE SIZE: 4k words for a comprehensive one-pass compiler; 8k words for special purposes, such as an extended load-and-go FORTRAN IV compiler.

WORD SIZE: 16, 18, 24, 28, 30, 32, 36, and 48 bits (Mesa personnel have solved the problems imposed by these varied word lengths).

INPUT/OUTPUT COMBINATIONS: paper tape; on-line flexowriter; punched cards; magnetic tape, discs, or drums; or any combination of input and output devices.

COMPILING SPEED: typical internal compilation speeds are 750 to 2,000 lines per minute.

CODE OPTIMIZATION: elimination of common subexpressions, redundant index loads, unnecessary load and store operations, and redundant terms; evaluation of logical expressions at compile time; and the use of algorithms to minimize sign parity operations and to remove common subexpressions as factors.

DEBUGGING AIDS: memory type-out routine, selective memory clear, breakpoint type-in program, symbolic output listing, run-time trace, multiple-format memory dump, and a printout of incorrect statements at the source code level.

ADVANCED FEATURES: dynamic storage allocations and recursive subprogram calls, real-time interrupt operation, mixed-mode arithmetic, Hollerith and logical assignment statements, in-line assembly, generalized DO indexing and array subscripting, program chaining, and run-time tracing, as well as many other features.

DELIVERY TIME: from 6 months. DELIVERY COST: from $40,000.

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