Fourth-generation languages (4GLs) and personal computers

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ABSTRACT

This paper describes how fourth generation languages (4GLs) evolved from enhanced query languages and report generators into applications development tools. Pioneers, such as MAPPER, NOMAD, RAMIS, SQL, and FOCUS are example nonprocedural 4GLs with excellent records. Another area that offers the promise of 4GLs in the next generation of development are the relational databases designed for microcomputers. The third origin of 4GLs is in languages like PRO-IV, SALVO, and REVELATION, which were developed originally as application development tools.

The increases in numbers and capabilities of personal computers demonstrate the need for greater understanding of 4GLs since most of them fit on these small machines. Of special note is the upgrade of the IBM Personal Computer XT to an IBM XT/370 and the software becoming available to use on this equipment. This is but one of the many examples where less expensive hardware is changing the entire concept of corporate computing and applications development by users.
INTRODUCTION

One of the primary reasons why corporations, government agencies, and other organizations have so readily accepted personal computers has been their use in generating electronic spreadsheets. Even so, many did not realize the increasing use of personal computers until Portia Isaacson’s panel discussions at NCC 1983. 1 Even her forecast was exceeded by International Data Corporation’s statement that the “U.S. personal computer market will surpass mainframes by 1984.” 2

James Martin has enabled the computer industry to recognize the benefits of fourth-generation languages (4GLs) through his seminars and his book Applications Development Without Programmers. 3 I have used this text in four graduate courses that are part of an M.S. degree in management information systems (MIS). Each time I point out to my students that the title can be misleading because a large volume of programming is necessary, although most of it is transparent to users. For example, the software for a database package with its own 4GL for my IBM Personal Computer XT requires nine double-sided, double-density floppy diskettes to hold the two million bytes of the PC/FOCUS package.

DEVELOPMENT OF 4GLs

As yet there are no standards for 4GLs. Martin and McClure 4 point out that these languages were created to enable non-programmers to obtain results from computers and to greatly speed up programming. Most 4GLs link into a database, either one created by the user using the 4GL or one created by other software like IMS, IDMS, or ADABAS. Higher-level third-generation languages like ALGOL, FORTRAN, COBOL, PL/1, and now Ada are procedural languages. 4GLs are described as nonprocedural because they specify what is to be accomplished but not how it is to be done. Many professional programmers do not consider the use of 4GLs to be programming. However, a user can obtain fast results from a computer by using some brief 4GL statements that would take many lines of third-generation language code to duplicate. On the other hand, these 4GLs are not yet intended to be used for all computer applications, and it may be a long time before they are. 4

We use the term user-friendly to describe the language we know. However, this term is used by almost all 4GL sales personnel, whether or not it is applicable. Martin applies the two-day training course to test user-friendliness. If a user can learn to become comfortable with a 4GL product and carry out useful work with it in two days without the need to return to class after a break of a week or two, the term user-friendly can be applied. 5

Professor Daniel Teichroew has been recognized for a number of years as a leading pioneer in systems analysis automation with his Information System Design and Optimization (ISDOS) Project at the University of Michigan. 6 Professor Teichroew’s project was extended (under the direction of Professors Benn R. Konsynski and Jay F. Nunamaker at the University of Arizona) and PLEXSYS, designed as an analyst’s and user’s workbench to facilitate the development of information systems. 7 These projects have provided much background, from which 4GLs have emerged.

About a decade ago the information center concept originated at IBM Canada. 8 The objective was to encourage computer users to learn to help themselves rather than relying entirely on computer professionals, systems analysts, and programmers to develop all their applications. Forms of the information center concept have been used by many organizations for many objectives. Special groups have been assigned to help users learn to use report generators, screen generators, query languages, statistical packages, graphics, spreadsheets, and decision support system applications. Some organizations use the information center to give users advice on which microprocessor to buy and the best software for their use. Martin, however, began stressing the use of 4GLs in the information center environment. Even though many organizations have been using a form of the information center concept to help users help themselves in a number of ways, it took IBM to formalize the concept and to educate us in its acceptance.

A 30-month backlog in applications design seemed to be agreeable to most discussants at the ACM (Association for Computing Machinery) 1982 conference in Dallas. This backlog did not begin to include the invisible backlog, identified by Martin as the requests users do not submit because they know the new requests will merely be added to the existing backlog. 9

Instead of information centers’ reducing applications development backlogs, they began to be used to “rob Peter to pay Paul,” as pointed out in a very sobering Computerworld editorial. 10 As users become more familiar with what computers can do, they request more and more computer support. Although this situation can defeat the initial primary purpose, in the long run the information center staff will be accomplishing what should have been done for many years—getting users involved in helping themselves by greatly reducing their reliance on computer professionals. The concept has been implemented in the St. Louis area, where more than three dozen organizations belong to SLICE, the St. Louis Information Center Exchange.

MAPPER, accepted for many years as an application development tool, is now commonly referred to as a 4GL. For example, MAPPER was being used by the Santa Fe Railway...
to develop major applications in 1976. Similar examples, some even earlier, can be given for APL, NOMAD, RAMIS, and FOCUS. However, it took James Martin to identify these as fourth-generation languages. Care must be used when describing 4GLs, since the term is accepted for MAPPER, NOMAD, RAMIS, and FOCUS; however, in the case of ADABAS, the 4GL is NATURAL. On the other hand, Applied Data Research calls its DATACOM/DB a fourth-generation database and its ADR/IDEAL an application development system rather than a 4GL.

STATE OF THE ART

Organizations that use database management systems like IBM's IMS or Cullinet's IDMS also use a software package such as FOCUS to organize extracts of the database, making this separate database available to users. When a personal computer is used in an IBM 3270 environment (it looks like a 3270 to the mainframe), the user has all the benefits of the FOCUS package, including the use of the 4GL to manipulate the data with few instructions. This 3270 environment reduces costs of telecommunications and the cost of the computing load on the mainframe. Of course there are some problems of data redundancy, data updates, recovery, and security (to name a few); but in most cases the advantages outweigh the problems by merely requiring that users not eliminate, update, or add to the main corporate database. On the other hand, the data organized as a FOCUS database can be manipulated in any manner desired by the user without damage to the corporate data.

FOCUS was the first software package of its type with its own 4GL to make a personal computer version, PC/FOCUS, for use in a standalone environment. My first release arrived in the summer of 1983. This is the package referred to previously that amounted to two million bytes. This package provides most of the capabilities of the package designed for mainframes and should not be considered a subset of the older package. The obvious limitation is in the amount of data that can be handled on the smaller computer.

During the summer of 1983 numerous articles and advertisements began comparing database management systems for micro/personal computers. One such article by Robert Bowerman in Datamation analyzed 24 relational database systems. It seemed that the relational packages with the least to offer had the biggest promotion budgets. Bowerman did not describe one of these packages as having a 4GL.11 On the other hand, Professional Information Systems, Ltd., describes a number of packages as fourth-generation software packages that operate on personal computers: dBase II, Dataflex, Pearl, Quick & Easy, Condor, Knowledge Man (for Management), and Data Fax.12 However, none of these appear to have a 4GL as defined in the context of this article. MDBS III is a similar software package that earned special mention because it is a network/hierarchical database management system that can be described as IBM's IMS on a PC. Spreadsheet, database, and graphic functions are combined in Lotus 1-2-3 in an early attempt to integrate software packages; but a 4GL is not yet available. No doubt the next generation of these micro/personal computer software packages will contain

4GLs. They will be suitable for inclusion in a similar discussion at NCC 1985! What really eliminates a more detailed discussion of them now is that the user interface takes more time to design and program than could ever be tolerated with a 4GL.

Brown University's NSF-sponsored Instructional Computing Laboratory is organized around professional work stations in a network concept using Apollo hardware and its Apollo Domain System. This concept introduces students to the desirability and viability of personal computing on powerful work stations connected in a high-speed resource-sharing network rather than on standalone hobby microcomputers. At Brown the language PROLOG is considered to be a 4GL rather than the 4GLs identified by this discussion.

PRO-IV is an example of a 4GL designed from the start as a development tool for use by both users and computer professionals. My personal observations of its development began in 1981 when the software was undergoing testing for implementation on microcomputers from four different vendors. By NCC 1982 many people saw the PRO-IV display at the CIE Systems booth. By NCC 1983 PRO-IV was being demonstrated on Microdata equipment under the trade name ALL and was announced for use on DEC equipment and the IBM Personal Computer XT.14 Two competitors with similar products are SALVO from Software Automation and REVELATION by COSMOS, Inc.

As this is being written, the computer industry is beginning to realize the impact of IBM's announcement of October 18, 1983, that its IBM Personal Computer XT can be upgraded to the XT/370 status, or the upgrade purchased as a separate unit.15 I have made the comparison that my own XT looks like an IBM system/360 Model 40 or 50 sitting on the desk. Now it can be said that when it is upgraded to the XT/370 the PC will resemble an IBM System/370 mainframe. As pointed out by Wendy B. Rauch-Hindin during the SIGBDP breakfast at the ACM 1983 conference in New York, this means that the software and programs written to run under the VM/CMS and other 370 operating systems will run on the XT/370. Of major importance to organizations with large mainframes is their interface with micros.16

Numerous FOCUS competitors are announcing their software for use, like PC/FOCUS, directly on personal computers. These announcements, such as those about NOMAD 2 from D & B Computing Services (formerly NCSS), System W from COMSHARE, IDMS/R from Cullinet Software, Inc., and ADR's IDEAL, demonstrate that the vendors are taking advantage of the IBM Personal Computer XT and the enhanced XT/370. Others have made similar announcements or are sure to make them, including IBM for its Data Base 2. These systems will find many users in plants, sales offices, divisions, branches, subsidiaries, and small organizations.

In summary, 4GLs suitable for users as well as computer professionals are emerging from three primary sources: (1) database management systems designed for mainframes that include a language (a 4GL) capable of doing joins, for report generation, for query, and for prototyping administrative and business computer applications; (2) relational database management packages designed initially for personal computers with integrated spreadsheets and other functions, including a
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4GL, for an applications development tool; and (3) 4GLs designed originally as applications development tools.

With the emergence of 4GLs there are some new problems. One concern is for the expense involved when large numbers of personal computers are purchased. Of major concern is the protection of organizational data. IDMS/R from Cullinet Software, Inc., provides for a separate but interconnected information database for data extracted from the production database for downloading to the IBM Personal Computer XTs.  

According to Harold Uhrbach, over 800 organizations have written software in anticipation of their corporate and organizational database protection problems. This software is in the form of database input/output (I/O) controllers, or data I/O controllers where there are multiple databases.  

Organizations using software with 4GLs need to provide data administrators with the capability of involving users in modeling database structures. Users can be taught how to work with database administrators to obtain inputs from the administrators’ vast knowledge of user experience. On the other hand, database administrators must be expected to realize the importance of data normalization and teach users to understand the concept.  

All current software packages with 4GLs have limitations and are not capable of generating all applications desired. These software packages are not all designed with an escape feature that permits modules written in a procedural language to be added to increase their use. In other cases it is necessary to make the proper choice among the software items available. For instance, if there is a heavy requirement for use of mathematical techniques for optimization—common in DSS applications—the choice could be either EXPRESS or COMSHARE’S System W. Information center managers need to realize these capabilities and limitations and encourage their superiors to provide their centers with more than one software tool when the requirements so indicate.

REFERENCES
