OASIS–A CLOSER LOOK*

- The design and implementation of a computer-based information system for research and for outlook and situation processsing within the Economics Statistics, and Cooperatives Service uncovered many critical areas: user orientation, data management, analytical capability, and clarity of output. Many computer-related design criteria were considered, such as free-format vocabulary, extendability, linkage to different data and program storage devices, and error detection-correction capabilities. Data storage and manipulation techniques were emphasized since these form a vital part of the outlook and situation process. The resulting system is one in which the casual or novice user can communicate a problem to the computer in a natural manner with little knowledge about programming or internal workings of the computer.

- Keywords: Information management, data bases, programming languages, computers, research support systems.

Rapid, accurate, and easy flow of information within the Economics, Statistics, and Cooperatives Service (ESCS) depends on a computer system. As authors of the first article in this issue we described the need for and development of the computerized outlook and situation Information system (OASIS), and we explained its use within the ESCS forecasting process. In this article, we present a more detailed description of OASIS. Because it is important to understand the philosophy behind OASIS, we will examine the criteria for the system, as well as its capabilities.[1]

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[1] The description of the system represents only its highlights. Additional documentation is available from the OASIS office in ESCS and from the Speakeasy Center at Argonne National Laboratory. See also the references at the end of the article. The system, including software and data base, is currently available only to USDA employees located in Washington. Others can, however, obtain the software by joining the Speakeasy Users Group (contact the Speakeasy Center) and they can obtain the historical data base from ESCS.

THE PURPOSE FOR OASIS

The basic reason OASIS exists is to enable its users to store, manipulate, and display information as desired with a minimum of effort and wasted time. Within ESCS, however, a substantial amount of research and analysis is used in the outlook and situation process. Thus, the OASIS task force recognized the benefits of a system that would support both research and forecasting activities. With such a system, the end result, the report, would emerge as a natural result of the underlying analysis. While most of the phase one implementation of OASIS involved data management and display components, the marriage of the analysis and research components to them was kept in mind, especially in selecting an operating system.

More specifically, the long-range OASIS goals are: (1) to provide an effective time-series data management system for outlook and situation and research activities; (2) to assist in an integrated, comprehensive flow of information within ESCS; (3) to increase the stock of user-oriented tools; and (4) to provide a central focus for the agency's outlook and situation modeling efforts.

CHOOSING/DESIGNING THE OPERATING SYSTEM

Build a system that even a fool can use, and only a fool will want to use it.
—Shaw's Principle

The basic criterion for OASIS was that it be an interactive, well-documented, user-oriented system capable of providing results quickly. The following additional criteria were also important.

Additional Criteria

OASIS must also operate in a "batch" environment so that large or low-priority requirements can be filled at lower dollar costs. The same commands and syntax should be used in both interactive and "batch" modes.

The system should incorporate facilities for the retrieval of variables with different structures (such as scalars one- and two-dimensional arrays of numbers and literals) into a temporary workspace, the manipulation of these objects, and storage of the results.

The vocabulary should be "free-format" and extendable through standard programming to accomplish additional tasks. Some mechanism for the creation of "pro-

grams" of the system's vocabulary should be provided to help with recurring or iterative tasks, and some method should exist for storing and retrieving these "programs".

Individual users should be able to maintain their own libraries of temporary data, program, and vocabulary extensions, so, they can keep their own materials without affecting either the performance or the cost for other users.

Design Alternatives

The OASIS task force had several alternatives available. Excellent software for the individual pieces of the overall computer system exist; there are data base management systems, statistical packages, linear programming systems, and the like, which satisfy very demanding people. But they satisfy only a small part of the requirements for OASIS. The task force could have chosen one system to satisfy the numerical information communication needs, another to satisfy the text communication, a third for econometric modeling, a fourth for linear programming modeling, and so forth, and it could have tried to merge them together.

Ad hoc merging was rejected for several reasons, First, it was felt that an integrated system would serve not only to link the various parts, but as a basis for common communication among users. Second, the time available for the task force to complete the work was very short. Finally, a system that already met several of the needs would allow concentration on only those pieces that were weak or missing.

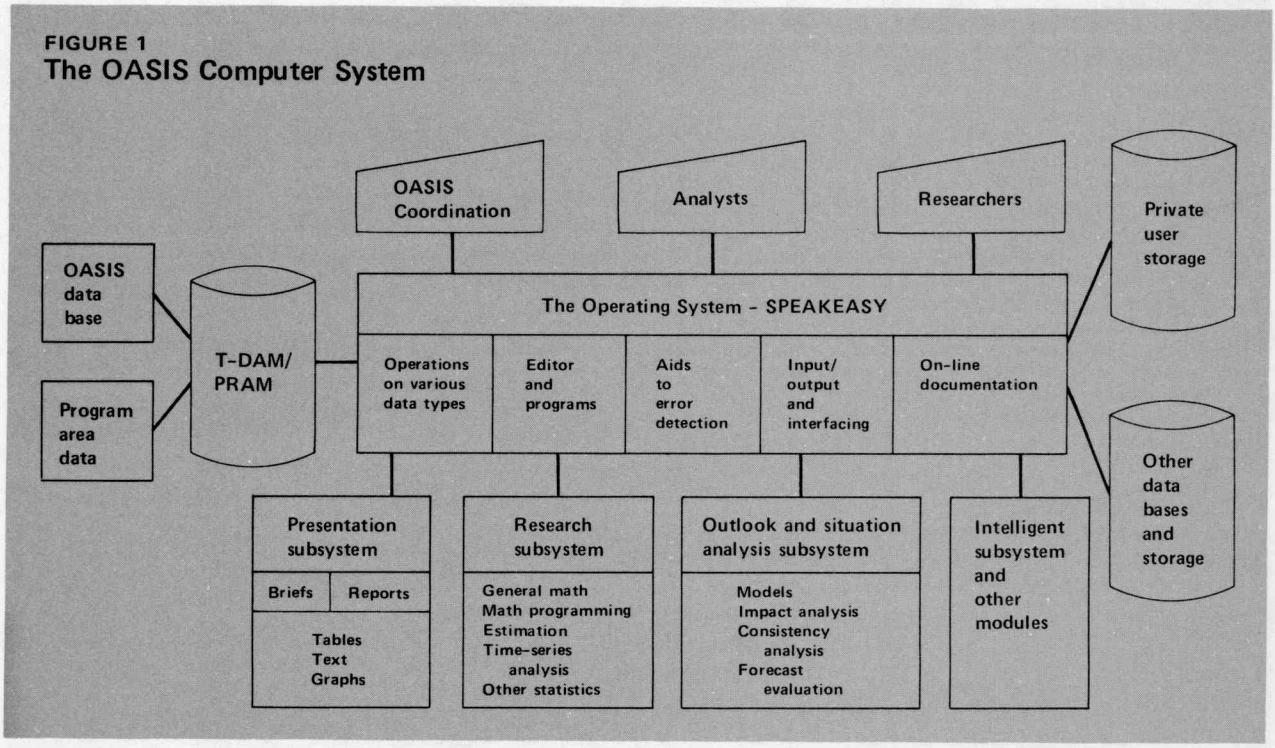
Selection of Speakeasy

A system already in use within ESCS was chosen because it met more of the criteria than any other: Speakeasy. Originally designed as a tool for researchers in the physical sciences, Speakeasy has been used more and more in the social science community. The Federal Reserve Board added many econometric routines to the system for its research staff. There are more accesses to Fedeasy, the Federal Reserve version, than to any other system including compilers and utilities. As Speakeasy was already being used in ESCS, it had the advantage of familiarity. In addition it already had a modular connection to a time series data management system and some tabular and graphics capabilities. The key factor, however, was that the Speakeasy processor is designed so that extensions to its capabilities can be made in a standard, yet flexible manner.

Adding some information communication modules and improving others gave the OASIS task force a way to develop a system with a much broader range of capabilities than any other publicly available package and to make this system operational within the very severe time constraints imposed by ESCS needs.

The most important reason for choosing Speakeasy is

FIGURE 1
The OASIS Computer System



its basic design. The system's designers realized from the start that attempting to build into a single processor as many capabilities as Speakeasy contains would result in a hopelessly complex package. Instead, they built a processor with only a limited set of operations and added to these operations with a network of attached libraries. In other words, Speakeasy is a modular system. The processor and the libraries are separate. Users can add, and have added, their own libraries. These libraries are all independent; their inclusion or removal does not affect the integrity of the processor. The additions for OASIS increase the power of the system, but they do not interfere with existing capabilities of Speakeasy.

THE OPERATING SYSTEM

A graphic version of OASIS is shown in figure 1. The function of the operating system, at the center of the computer system, is to provide effective applications control. The user retrieves data from the data bases and navigates it through assorted analyses into display or storage for further use. Table 1 shows some of the capabilities. Their extremely broad range makes it difficult to categorize or list them effectively in the limited available space. Those wishing more detail should contact the Speakeasy Center.

DATA MANAGEMENT AND DATA BASES

A relevant, well-maintained data base is, of course, essential for outlook and situation work. Data management is necessary to assure the integrity of the data and to provide for timely updating and a consistent variable nomenclature. Rapid data access, though, is only one condition for complete data support. Thus, a program of thorough, careful data updating and maintenance is also needed to assure both quality and timeliness.

In addition to the primary OASIS data base, users need access to other data. Detailed data maintained by other ESCS/ECON units, ESCS/STAT units, other USDA agencies, and other outside sources are all helpful

Table 1—Capabilities of the operating system, OASIS

Data types	Real or complex numbers Character or name literals Scalars One- and two-dimensional arrays Vectors Matrices Sets
Function types	Element-by-element functions Sums and products of elements Structural information and transformation Functions of one-dimensional arrays Matrix algebra Set algebra Statistical functions Logical functions
Editor and programs	Editor similar to IBM TSO editor WHOOPS command to reverse effect of last change made by editor Loops, branches, and user prompts in programs Programs may be entered at any statement label
Aids to error detection	Automatic printing of selected variables Logical traces Selected output if error occurs Execution of specified statement if error occurs Branching control if error occurs Pause after given number of steps Correct a program during execution
Fortran input/output and interfacing	Formatted and unformatted Fortran read, write, and punch Call Fortran function or subroutine Read SPSS save files Fortran and PL/1 programs can read/write data to user libraries
On-line documentation	Help documents for each command Examples of many commands Tutorials on system use

for outlook work and they are sometimes necessary for research.[2] Thus, OASIS must be linked to other data management systems. In addition, individual users also need to be able to store their own programs and data. OASIS currently provides facilities to maintain its central data base, to access any other from T-DAM (Time-Series Data Access method), to access data in some commercial data management systems, read and write character image files, and to maintain private libraries for users.

T-DAM

T-DAM is the data management system used for the OASIS data base. It is specifically designed for economic time-series data. In 1976, development began on T-DAM because there was no efficient time-series data management system available to the former Economic Research Service.

T-DAM can contain any number of variables, and it has 50 million observations. Variables are divided into logical groups (each group has a 3-character name and belongs to a specific user or project), plus a 20-character variable name (though OASIS allows only 7 characters for Speakeasy use). OASIS data currently make up about 10 percent of the total data available in T-DAM.

While all OASIS users can read almost all T-DAM data, a logical group's owner can restrict even the reading of his data to specific persons. Users can create new variables and update existing variables only within logical groups that they own. Both password-protection and use-auditing systems are included in T-DAM.

T-DAM allows various periodicities, and the user may specify the beginning and ending periods. All retrievals may be started at the same time period, and the retrieved results will be padded; that is, equivalent dates are alined in columns.

Other salient features of T-DAM appear in table 2. PRAM (Page Relative Access Method) is a recently developed enhancement which improves both space management and user performance.

Table 2—Features of T-DAM-PRAM, data management system used in ESCS

Feature
Ability to interface to any user's program via a "standardized" subroutine call
Almost unlimited amount of data on-line at one time
Data series logically divided into "logical groups", but in one centralized physical file
System operable in both interactive and batch modes
Data access protected so only the owner of a "logical group" (or someone he specifies) can alter his data, and so the owner can restrict even the reading of his data when desired
Completely mnemonic names for the data variables
Capability for maintaining documentation information, such as units of measure, source, description, owner, last updater, and date last updated for each variable
Flexibility of internal data formats, including INTEGER, REAL, and DOUBLE-PRECISION
Automatic handling of periodicities such as annual, quarterly, and monthly
Space-accounting facility which reclaims space from deleted variables, facilitates addition of new observations to an existing variable, and allows each variable to have an almost unlimited number of observations
Retrieval of any desired contiguous subset of possible observations
Auditing facility to log who (which user) is doing what to which data; can be valuable in tracking system or user problems and in supplying management information
Archive facility for holding logical groups of variables not currently required on-line (to reduce on-line disk costs), and to be a system backup
Linkes to various software packages, such as SAS, SPSS, TPL

Other Data Bases and Data Management Packages

As the operating system permits Fortran subroutine calls, it is relatively easy to interface OASIS with any commercially available, or user-developed data management package which has a Fortran interface. Some packages for which interfaces have been developed include Total, Ramis, Starmap, SPSS, and the Federal Reserve's MDL. The Fortran input-output capabilities allow interfacing (with some decrease in efficiency) with any data set or data management package formatted in either character image or Fortran unformatted format.

Private Storage for Users

OASIS provides users the ability to store data or programs using standard Speakeasy facilities. These include "mykeep" libraries, partitioned data sets whose members are read and stored with standard calls, a checkpoint facility, and a test version of generic and relational data bases.

The OASIS Data Base

If OASIS does not survive as a system that provides information to policymakers, the reason will be that the OASIS data base is not properly maintained. No information system will succeed unless its data are updated consistently, completely, and promptly. Therefore, the

[2] ESCS/ECON refers to the former Economic Research Service, and ESCS/STAT to the former Statistical Reporting Service. Both are now parts of the Economics, Statistics, and Cooperatives Service formed January 1, 1978.

OASIS task force spent considerable time determining the types of data in the data base, how they should be maintained, and by whom.

Hot data are those with major impacts on commodity markets, farm income, policy decisions, and so on. They are typically released in automated or routine published form, but their sensitivity means that they must be captured immediately and entered into the system quickly.

Automated data are those received on computer tape or other machine-readable form. One primary source may have data of interest to several program areas in ESCS divisions. Centralized collection and entry of such data is more efficient than allowing each interested group to collect the data.

Routine published data are periodically published in nonautomated form. Hot data may be included, but usually the publication will contain considerably more than this type of data. When a large number of variables are collected from a single publication, updates are best managed by keying in the data from published form directly into the data bank. Because the published data typically have a standard format, programs to prompt the terminal operator for the data are ideal. When only a few variables are involved, the data are best treated as routine and unpublished.

Routine unpublished data are routinely collected, but through means other than in automated or published form. Data acquired by telephone from other agencies represent an example. Ideally they should be entered on a standard form which can be keyed into the data base.

Derived data come from other data either by quantifiable or subjective procedures. The first type may be automated; the second may not. Finally textual information generated within ESCS for use in briefs must be entered into OASIS, and such text must be treated as hot data.

THE OASIS PRESENTATION SUBSYSTEM

An ounce of image is worth a pound of performance

—Peter's Placebo

The information presentation facilities were designed to have a set of commands for creating and maintaining table, text, and graphics units. Further, these units were to be merged into user-oriented products known as BRIEFs and REPORTs. The T-DAM data management system interacts with these BRIEFs and REPORTs so that data required for tables and graphs can be automatically retrieved for use.

Tables

Speakeasy offers a tabulate command which produces tabular listings of data. While this command is flexible, it does not offer such required features as footnotes, easy dating of periodicities, and multiple labels per data line. Therefore, a series of commands were set up to allow creation, alteration, and printing of table specifications. Clerical and research staff with no computer background have learned to create table specifications within a few hours. Tables are designed to be generated from within REPORTs and BRIEFs. They require a specific environment which is created by the commands REPORT, BRIEF, and SHOWTABLE. A typical table is shown as table 3.

Text

Textual material is required to explain "hard data" presented in tables and graphs. Therefore, OASIS needed facilities for creating, editing, and printing textual information. Speakeasy provides some textual facilities. It was determined that judicious use of these commands within a Speakeasy program would provide the basic facilities required for OASIS' initial operation. However, four new commands were added. Figure 2 shows a BRIEF, including text and a TABULATE table.

Graphics

Graphical displays are a highly convenient way of conveying economic information. An integral part of OASIS, they have two levels of implementation. The first level was developed at Communications Satellite Corporation and is supplied with Speakeasy. The second level is created by combining the first-level graphics commands with other Speakeasy commands into linkule-driven prompting programs. Both levels have unique advantages and limitations.

The graphics package as supplied with Speakeasy is designed to support many different terminal types. Others can be added by the installation without undue difficulty. The main feature is that all of the graphics commands are the same for all terminal types; thus, users need learn only one set of graphics commands.

While the standard graphics commands provide easily understood methods for generating tailored graphical output, however, users identified three needs that dictated the second level of graphics capabilities. First, policymakers often must have graphics quickly. These requests cannot be planned; frequently, they must be completed within 1 or 2 working days. Second, standard graphs are needed that can be easily reproduced following updates of the data series. Many ESCS program areas keep files of such graphs for a large volume of data, some of which are updated monthly. Third, many graphs are needed only once, either as an analytical aid or for a briefing. Often, the user drew such graphs by hand.

The OASIS task force had to provide for these needs in a comprehensive yet user-oriented manner, one that could adapt to users' different requirements. In any system adopted, updates had to be handled easily. Also,

Figure 2

Commodity Highlights

January 28, 1978

Crop and livestock production were large in 1977 and production will remain large in 1978. Plentiful supplies of feed are helping to encourage a continuation of the expansion in livestock and poultry feeding. This will boost meat output in 1978, even though slaughter of cattle coming off pastures and ranges likely will be down. And if crop farmers carry out their plans stated in recent planning intentions report, crop output will be large again this year, providing weather conditions aren't too bad.

Farmers have said that acreage planted to major crops may decline about 2 percent from 1977, with most of the avreage decline in wheat and cotton. Larger plantings for soybeans were partly offsetting. The indicated small reductions in plantings of feed grains suggest that few farmers are responding to the conditional set-aside feed grain program. Of course, farmers still have ample opportunity to adjust planting decisions in response to changes in price relationships among crops, the availability and costs of inputs, the final decision on whether a feed grain set-aside program will be available for 1978 crops, and the level of price support for soybeans. Also, weather is always an uncertain factor to be considered in planting decisions. These and the recent unrest among farmers make the planting intentions even more tentative than usual this year.

However, with recent widespread improvements in moisture conditions in the United States and generally good conditions abroad, prospective plantings would suggest U.S. crops of corn and soybeans could exceed likely utilization during 1978/79. If the wheat crop were reduced about in line with plantings, production may run a little below utilization.

Plantings of Major Crops (Millions of Acres)

CROP	CROPYR76	CROPYR77	PLANND78	PCTCHG78
Corn	84.4	82.7	80.9	-2.1
Sorghum	18.4	17	17.5	3.2
Barley	9.2	10.6	10.6	-.3
Oats	16.7	17.8	17.6	-1.2
Feed Grains	128.7	128.1	126.6	-1.2
Durum wheat	4.7	3.2	4.2	31.2
Other spring wheat	17.8	15.6	13.7	-12.2
Total spring wheat	22.5	18.8	17.9	-4.8
Winter wheat	57.7	56	48.1	-14
Total wheat	80.2	74.8	66	-11.8
Soybeans	50.2	59.1	63.9	8.2
Upland cotton	11.6	13.6	12.6	-7.3
Flaxseed	1.1	1.5	1.3	-15.6
Sugarbeets	1.5	1.3	1.3	4.5
Rye	2.7	2.7	2.9	7.8
Rice	2.5	2.3	2.5	9.8
Total	278.5	283.4	277.1	-2.2

U. S. DEPARTMENT OF AGRICULTURE
ECONOMICS, STATISTICS, AND COOPERATIVES SERVICE
OUTLOOK AND SITUATION INFORMATION SYSTEM

TABLE 3.--WORLD GRAIN PRODUCTION BY CROP AND MAJOR PRODUCING REGION

ID:	VARIABLE NAME	UNITS	1973 HISTORY	1974 HISTORY	1975 HISTORY	1976 HISTORY
1:	WHEAT (TOTAL)	1000 M.T.	372,005:	356,141:	349,198:	415,528
2:	U.S.		46,560:	48,496:	57,751:	58,296
3:	CANADA		16,159:	13,295:	17,078:	23,587
4:	ARGENTINA		6,560:	5,970:	8,570:	11,000
5:	USSR		109,784:	83,913:	66,224:	96,882
6:	EEC-9		41,393:	45,391:	38,105:	39,539
7:	OTH.W. EUROPE		9,372:	11,305:	10,397:	11,561
8:	E. EUROPE		31,631:	34,107:	28,485:	34,614
9:	AUSTRALIA		11,987:	11,357:	11,982:	11,713
			:	:	:	
10:	COARSE GRAINS	1000 M.T.	661,178:	621,536:	635,406:	693,875
11:	U.S.		186,777:	150,905:	185,057:	193,859
12:	ARGENTINA		17,935:	13,793:	12,438:	16,860
13:	CANADA		20,411:	17,436:	19,987:	21,125
14:	AUSTRALIA		24,976:	21,968:	20,702:	16,543
15:	BRAZIL		16,851:	16,926:	18,482:	19,381
16:	THAILAND		2,520:	2,730:	3,350:	3,000
17:	USSR		100,951:	99,744:	65,820:	114,979
			:	:	:	
18:	RICE ROUGH	1000 M.T.	223,469:	227,339:	243,109:	235,402
19:	U.S.		3,034:	3,667:	4,091:	3,777
20:	THAILAND		9,471:	9,570:	10,032:	10,428

many potential users of the new system did not have time to write and "debug" a level-one program whenever they needed a complex graph; thus, OASIS had to be able to meet their needs.

The solution was to install in the OASIS system a second graphics level consisting of linkule-driven Speakeasy programs which prompt the user for the appropriate parameters needed to create a graph and produce the desired graph with a single command. The graphics are also designed so that they can be driven by the REPORT and BRIEF commands.

This graphics facility has already demonstrated its worth, as it is quick and easy to use. While being developed, it was used to meet needs of Department and agency level policymakers. Production of a single graph takes about 10 minutes, specification and production included. Because little or no programming is involved, and on-line instructions are available for every portion of the OASIS system, the uninitiated can easily produce useful results in a short time. Several improvements will be made to the graphics at both levels, and the system will be able to provide more varied types of graphics. Figure 3 shows an OASIS graph.

BRIEFS

A BRIEF is a self-contained set of materials not alterable by the final user. It covers specific time periods and data, and it is produced for a specific purpose—generally to describe a current situation or to respond to a specific question.

OASIS briefs are designed to provide information to users who have a minimum knowledge of computer systems. While a report requires the user to specify time periods and some other optional information, a brief is completely self-contained. After typing "BRIEF(name1

name2 . . .)", the user receives briefings on the named subjects.

An extension of the briefing facility is the "time-stamped" briefing. Each BRIEF is recorded in a table with the date and time of its storage. Another table is kept in OASIS showing the last date and time that an authorized recipient of briefs received an updated listing of available briefs. When such a user types the OASIS command BRIEFME, an index of new or altered briefs is produced. After seeing this, the user can ask for a print-out of all indexed briefs or terminate the automatic briefing and, using the BRIEF command, request only certain briefs. At this time, the user's profile is altered to reflect that he or she is up to date.

Reports

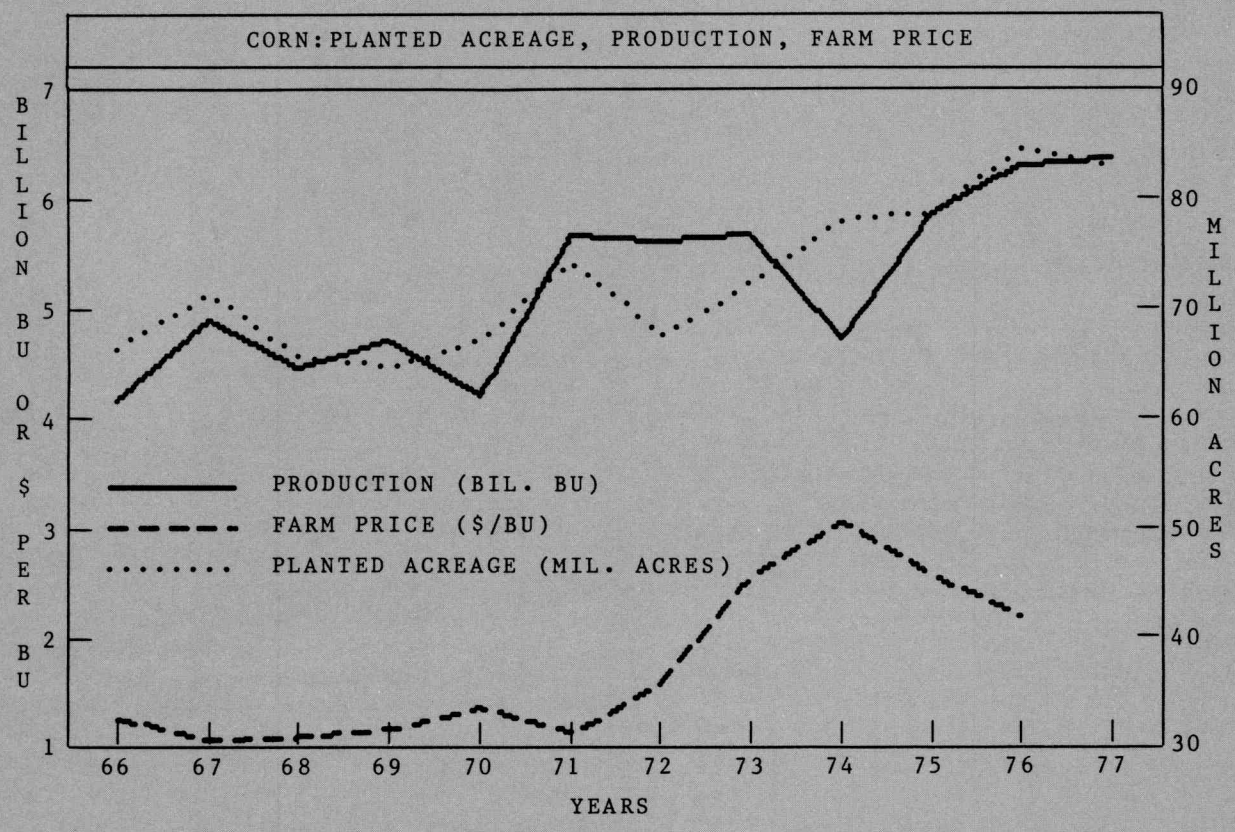
OASIS reports are predefined combinations of one or more tables, graphs, and text units. The time periods, forecast scenarios, periodicities, and some other environmental attributes are specified at the time the report is requested, allowing flexibility in displaying tables and graphs in response to ad hoc needs of researchers or analysts.

Technically, the REPORT command retrieves each requested report specification and writes its individual lines into one sequential file. The computer sets the environment based upon the parameters included with the REPORT command, and it shifts the control input from the terminal (or card reader) to that file of control cards.

THE GENERAL RESEARCH SUBSYSTEM

All of the general capabilities described above are useful in economic research. But Speakeasy users have been especially active in the areas of statistics and economics.

FIGURE 3
An OASIS Graph



OASIS contains probably the best system which is publically available for economics research. Other systems may be superior in one aspect, but none have the flexibility or the breadth of the Speakeasy/Fedeasy/OASIS system. Table 4 outlines some of the capabilities developed at various places: the Speakeasy Center, the Federal Reserve Board, Educational Testing Service, the University of Liege in Belgium, and ESCS.

Two examples illustrate how the general research subsystem of OASIS works—the OASIS aggregation routine for the Consumer Price Index(CPI) and two methods for calculating the coefficients of a two-stage least squares regression.

OASIS Routine for the Consumer Price Index

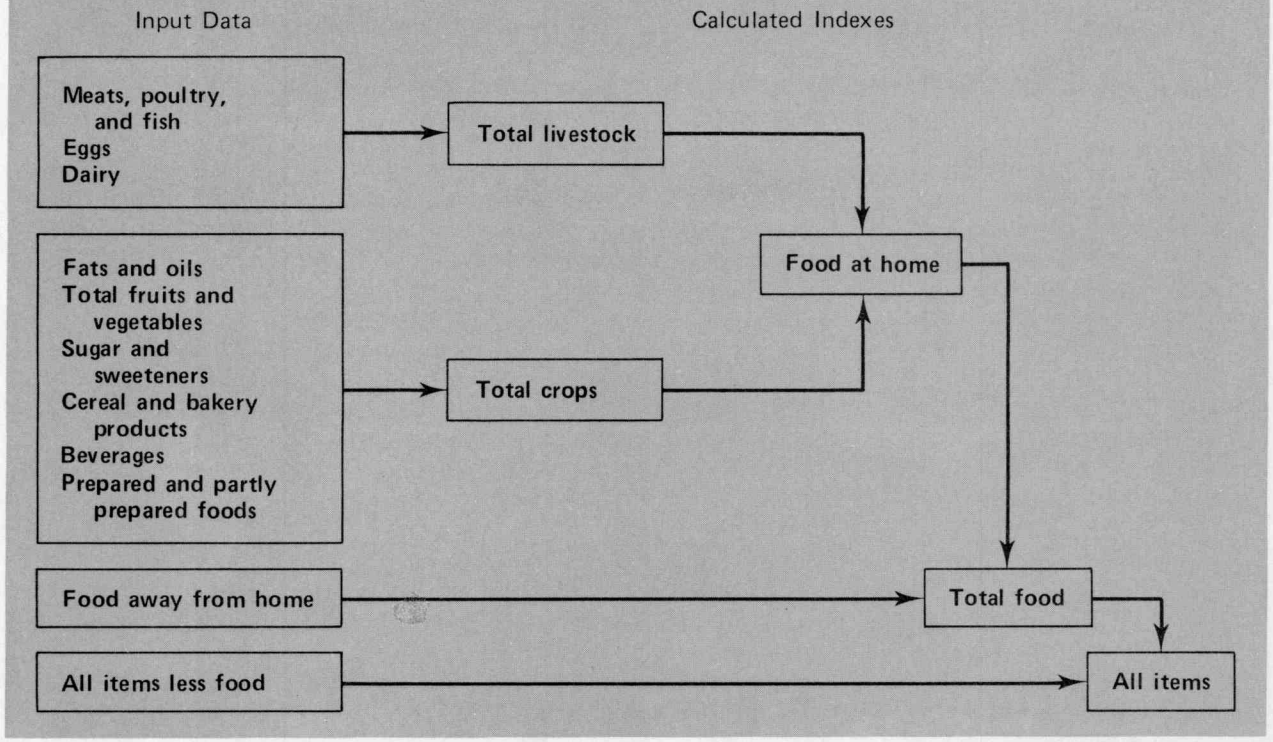
Figure 4 shows how the OASIS aggregation routine for the CPI operates. It starts with individual commodity groups, food away from home, and all items less food. Total crops and total livestock indexes are calculated, followed by food at home, total food, and, lastly, the total CPI. Figure 5 shows the program that calculates the indexes, and it shows the output.

Making the calculations is easy. CPI data and variable labels and weights are retrieved from a user library in statements 4 and 5. In practice, the CPI data are

Table 4—Capabilities of Research Subsystem, OASIS

Subject	Capability
General mathematics	Matrix algebra
	Set algebra
	Differential and integral calculus
	Differential equations
	Roots of polynomials
	Transformations of a variable
Mathematical programming	Linear programming
	Transportation algorithm
	Assignment algorithm
	Solution of under- and overdetermined system of linear equations
Estimation	Ordinary least squares
	Two-stage least squares
	Cochran-Orcutt and Hildreth-Lu corrections
	Polynomial distributed lags
	Shiller lags
	Random coefficient regression
	Nonlinear regressions
	Restricted least squares
	Probited analysis
	Ridge regression
	Principal components
Time series	Autocorrelation and autocovariance
	Partial autocorrelations
	Cross correlations
	Spectral analysis
	ARIMA modeling
	X-11 additive and multiplicative adjustments
Other statistics	Simple statistics
	Correlations
	Mean, variance, skewness, and kurtosis
	Standard error of the mean
	F- and *t*- probabilities
	Chi-squared probabilities and test
	Random numbers
	Frequency distributions
	Contingency tables
Other econometrics	Pooled time-series, cross-section estimation
	Moving averages and exponential smoothing
	Solution of nonlinear models

FIGURE 4
The CPI Calculator



retrieved from the OASIS data base. Input data are printed (lines 8 and 9); note use of "structured indexes" to print only the input data. Total livestock and total crop indexes are calculated (lines 12-17) by use of matrix multiplication and structured indexes. Other aggregates are calculated (lines 22-26) with array arithmetic and a loop; they could also be calculated with matrix algebra. Calculated indexes are printed (lines 29-30).

Two-Stage Least Squares Regression Coefficients

The second example shows two ways to calculate the coefficients of a two-stage least squares regression. Both methods are similar. The first method (lines 16-18 of figure 6) simply copies the formulas from a textbook into Speakeasy matrix notation. Someone just starting to use OASIS could do this work easily. A more sophisticated user would realize that this method involves numerical problems. The second method (lines 16-18) uses an extremely stable operator that solves over- and under-determined systems of linear equations. The second method is also easier to read.

OUTLOOK AND SITUATION ANALYSIS SUBSYSTEM AND OTHER SUBSYSTEMS

This subsystem consists of facilities specifically designed to support ESCS outlook and situation activities, several of which have been mentioned. They include the ESCS forecasting models; impact analysis facilities such as the cross-commodity model, Impact Multiplier System, and POLYSIM; consistency aids, such as the farm income and CPI calculators; and a forecast evaluation package that enables ESCS analysts to evaluate their forecasting accuracy. Some of these have been integrated into the OASIS computer system; others are being integrated.

While an intelligent subsystem and other modules do not currently exist, some work has begun on new tools to aid researchers and analysts. The intelligent subsystem will converse with analysts so that they can answer

FIGURE 5
CPI Calculator Program

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EDITING CPIDEMO
  1 PROGRAM
  2 $
  3 $      RETRIEVE DATA FROM USER LIBRARY
  4 GET CPI ON MYKEEP
  5 GETLIST WGTLABEL ON MYKEEP
  6 $
  7 $      USE STRUCTURED INDEX TO PRINT INPUT DATA
  8 II=INTS(1 9),13,15
  9 TABULATE LABEL(II,) ,  CPI(II,)
 10 $
 11 $      CALCULATE TOTAL LIVESTOCK PRODUCTS
 12 I=INTS(1 3)
 13 CPI(10) = ROWMAT(:W(I)) * CPI(I)
 14 $
 15 $      CALCULATE TOTAL CROP PRODUCTS
 16 I=INTS(4 9)
 17 CPI(11) = ROWMAT(:W(I)) * CPI(I)
 18 $
 19 $    IN A LOOP, CALCULATE FOOD AT HOME (CPI INDEX NUMBER 12)
 20 $                         ALL FOOD (CPI INDEX NUMBER 14)
 21 $                         ALL ITEMS LESS FOOD (CPI INDEX NUMBER 16)
 22 B=12,14,16
 23 FOR A=1,3
 24 C=B(A)-2
 25 CPI(B(A),)=CPI(C,)*W(C)+CPI(C+1,)*W(C+1)
 26 ENDLOOP A
 27 $
 28 $      USE STRUCTURED INDEX TO PRINT CALCULATED INDEXES
 29 II=10,11,12,14,16
*30 TABULATE LABEL(II,) ,  CPI(II,)
```

MEATS, POULTRY, AND FISH	186.8	184.8	187.3	186
EGGS	158	135	149	159
DAIRY	179	181.5	182	184
FATS AND OILS	198	200	201	202
TOTAL FRUITS AND VEGETABLES	195.2	203.2	201.4	195.2
SUGAR AND SWEETENERS	243	246	249	252
CEREAL AND BAKERY PRODUCTS	192	195	197	200
BEVERAGES	328	318	308	298
PREP. AND PART. PREP. FOODS	184	186	188	190
FOOD AWAY FROM HOME	208	212	215	218
ALL ITEMS LESS FOOD	184.7	188.2	190.5	194.2
TOTAL LIVESTOCK	182.7	180.9	183.5	183.9
TOTAL CROPS	211.7	214.8	214	212.1
FOOD AT HOME	196.8	197.3	198.3	197.5
ALL FOOD	199.1	200.4	201.8	201.9
ALL ITEMS	188	191	193.1	195.9

FIGURE 6
Methods for Calculating Coefficients of Two-Stage Least Squares Regression

```
EDITING TWOSLS
  1 PROGRAM
  2 $      THIS PROGRAM CALCULATES TWO STAGE LEAST SQUARES
  3 $      IN TWO DIFFERENT WAYS.  THE SECOND WAY IS
  4 $      MORE STABLE AND EASIER.
  5 $
  6 $      THEY BOTH USE THE SAME NOTATION.  IT IS ASSUMED
  7 $      THAT ALL VARIABLES ARE DEFINED.
  8 $
  9 $      X  = MATRIX OF ALL PREDETERMINED VARIABLES
 10 $      Y1 = MATRIX OF ENDOGENOUS VARIABLES ON RHS OF EQUATION
 11 $      X1 = N X M MATRIX OF PREDETERMINED VARIABLES IN EQUATION
*12 $      DV = N X 1 MATRIX OF THE DEPENDENT VARIABLE
 13 $
 14 $  METHOD 1; EQUATIONS AS COPIED FROM TEXT
 15 $
 16     Y1HAT = X * INVERSE(TRANSPOSE(X)*X) * TRANSPOSE(X) * Y1
 17     Z = X1;   Z(,M+1) = Y1HAT
 18     INVERSE(TRANSPOSE(Z)*Z) * TRANSPOSE(Z) * DV
 19 $
 20 $  METHOD 2
 21 $
 22     Y1HAT = X * SIMEQUAT(X Y1)
 23     Z = X1;   Z(,M+1) = Y1HAT
 24     SIMEQUAT(Z DV)
```

policy questions more easily and consistently. Another module being developed helps analyze econometric models, and it shows the logical structure among the variables.

CONCLUSIONS

Blessed is he who expects nothing for he shall not be disappointed.

Franklin's Rule

While acknowledging that OASIS could not operate without data and the appropriate manipulative tools, the task force realized that the entire process had to be engineered to account for the basic fallibility of the human animal. The software that produces the tables, text, and graphs allows the most unsophisticated user the maximum number of opportunities to make a maximum number of mistakes and still correct the errors. This ability removes the system from the purview of the technicians and places it directly in the hands of users who might want to take advantage of the full range of services under the OASIS umbrella.

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