COCOMO APPLICATION IN
A MANPOWER MANAGEMENT SURVEY

1. I WOULD LIKE TO PRESENT A UNIQUE APPLICATION OF COCOMO METHODOLOGY
IN A MILITARY ENVIRONMENT. I WILL MENTION SEVERAL PROBLEMS AND HOW
THEY WERE DEALT WITH, SOME PROBLEMS STILL TO BE FACED, AND THEN
SOLICIT YOUR CONSTRUCTIVE COMMENTS CONCERNING OUR METHODS.
I SHOULD EMPHASIZE THAT THIS IS NOT AN OFFICIAL NATO PRESENTATION AND
DOES NOT REPRESENT OFFICIAL NATO POLICY. IT IS SIMPLY A STATEMENT OF
MY OWN VIEWS.

2. THE NORTH ATLANTIC TREATY ORGANIZATION (NATO) IS AN INTERNATIONAL
MILITARY AND CIVILIAN BODY WITH ALL OF THE CHARACTERISTICS WHICH THESE
TERMS IMPLY. THERE ARE SEVERAL HEADQUARTERS LOCATED FROM NORWAY TO
ITALY, IN TURKEY AND ALSO IN NORTH AMERICA.

3. THE GROWTH OF ADP REQUIREMENTS AND CAPABILITIES WITHIN NATO HAS
BEEN SLOW.

4. NATO MANPOWER IS PROVIDED BY THE MEMBER NATIONS WHICH AGREE TO
SHARE THE WORK LOAD. REQUESTS TO THE NATIONS TO PROVIDE INCREASING
NUMBERS OF ADP CAPABLE PERSONNEL ARE DIFFICULT TO MEET BECAUSE OF
NATIONAL SHORTAGES. IT IS OBVIOUS, THEN, THAT ADP PERSONNEL ARE NOW
RECOGNIZED AS A SCARCE RESOURCE.

5. IN 1986 THE NATO MILITARY COMMITTEE DIRECTED THAT A NATO WIDE ADP
MANPOWER SURVEY BE CARRIED OUT. A SURVEY GROUP WAS APPOINTED TO REVIEW
THE MANAGEMENT, ORGANIZATION AND COMPOSITION OF ALL INTERNATIONAL ADP
POSTS IN NATO MILITARY BODIES. THE PURPOSE IS TO ESTABLISH A
BASELINE OF CURRENT ADP MANPOWER REQUIREMENTS FOR THE FUTURE TWO OR
THREE YEARS.
The survey team was directed to employ COCOMO for the ADP manpower estimation. They were also to make recommendations that would assist NATO military bodies achieve their mission, streamline procedures, economize their use of manpower, and operate more efficiently.

6. The NATO ADP environment consists of several large mainframes at host sites, not collocated with the various headquarters. Each headquarters has either a software support center or an information systems work center. These centers provide ADP user support in the primary functional areas of operations, intelligence, logistics and communications. Most of the applications software is run on the command and control information systems (CCIS). However, there is a growth of micro computers in all of the headquarters and management information systems are scheduled for office automation over the next five years.

7. The first problem of the survey group was to determine whether the COCOMO methodology could be practically applied in the unique NATO environment. The group members attended a course on the application of COCOMO. Then they went through a learning experience during a test period in which COCOMO techniques were applied to the maintenance output of a software support center (SSC). (NATO policy does not allow in-house development, so physical output consists of adaptive, corrective and limited perfective maintenance). The best available data for the previous year of operation was used. Cost drivers were agreed between the survey group and the SSC. The FSP was calculated and the figure compared with the actual number of personnel who had performed the maintenance. The comparison showed a high degree of confidence in the methodology.
8. IT QUICKLY BECAME APPARENT THAT COCOMO DERIVED FSP DID NOT TELL
THE WHOLE STORY. THE FSP FIGURE DID NOT INCLUDE THE PERSONNEL REQUIRED
FOR DATA BASE ADMINISTRATION, HARDWARE CONFIGURATION OR CLERICAL
ADMINISTRATIVE FUNCTIONS. THESE WOULD HAVE TO BE DERIVED IN A
DIFFERENT WAY, AND THE METHOD SELECTED WAS THE MANPOWER SURVEY AUDIT.

9. OUR INTEREST HERE, HOWEVER, IS IN COCOMO APPLICATION SO MY
COMMENTS WILL BE LIMITED TO THE COCOMO PART OF THE SURVEY.

10. THE SURVEY TEAM IDENTIFIED THREE PERSONNEL BOUNDARIES WHICH ARE
REPRESENTED AND DESCRIBED AS FOLLOWS:

FIRST: ANALYSIS_BOUNDARY

THE PERSONNEL WITHIN THE ANALYSIS BOUNDARY ARE THE ADP
PERSONNEL WHO CONSTITUTE THE SOFTWARE MAINTENANCE AND DEVELOPMENT
TEAM. THE TASKS ADDRESSED BY THIS TEAM AND THEIR PERSONNEL
ATTRIBUTES ARE THE INPUT FACTORS FOR THE COCOMO MODEL.

SECOND: PREDICTION_BOUNDARY

THE PREDICTION BOUNDARY INCLUDES ALL THE ADP PERSONNEL WHO
ARE PREDICTED BY THE COCOMO MODEL AS BEING REQUIRED BY THE
ORGANIZATION TO ADDRESS THE DESIGNATED SOFTWARE MAINTENANCE OR
DEVELOPMENT TASK. THIS INCLUDES ALL THOSE UNDERTAKING SOFTWARE
PROJECT MANAGEMENT ACTIVITIES OR OTHER ACTIVITIES INCLUDED IN THE
WORK BREAKDOWN STRUCTURE OF THE COCOMO MODEL. THE SYSTEMS
MANAGER, ADP SECURITY OFFICER, DATA BASE ADMINISTRATOR AND
COMPUTER OPERATIONS PERSONNEL ARE EXCLUDED. OTHER ADP
PERSONNEL NOT COVERED BY THE COCOMO MODEL BY VIRTUE OF THEIR
DESIGNATED TASK, OR THOSE INVOLVED IN SYSTEMS ANALYSIS FOR
DEVELOPMENT BY EXTERNAL CONTRACTS ARE EXCLUDED AS WELL.
THIRD: **ORGANIZATION BOUNDARY**

**This boundary includes all personnel - ADP and non ADP - within the organization.**

11. We are concerned with data collection in the analysis boundary. Several problems were encountered because of the following situations:

**First:** Age and condition of the software. Much of the software being maintained had been developed in the late 1970's and early 1980's by contractors who used irregular programming techniques and did not produce proper documentation. Subsequent maintenance was not properly documented and current maintenance could only be done by those analysts or programmers with long experience on these systems.

**Second:** Proliferation of hardware of many types and application software written in a variety of languages. These factors sometimes yielded an FSP all out of proportion to the number of lines of code being maintained.

**Third:** The analyst or programmer mix of multinational military and civilian personnel. Civilians generally have the advantage of many years of experience on site. The military have non standard backgrounds; zero to three years on site (often with no previous experience on the types of systems used in this environment) and variable language experience. Newly posted personnel have to wait for training courses which do not coincide with the posting season.
12. With careful application, COCOMO seems capable of handling most of these problems, as well as the security and training requirements.

13. A more difficult problem, and a continuing one, stems from the different perspectives of the survey team and the SSCs. The goal of the SSC is to support the user community to the fullest extent possible. It feels it can only do this if it has sufficient manpower. It tends to keep application software subsystems in its inventory even though they may be seldom or never used. It tends to overestimate the size of the subsystems and their act, to upgrade the mode (for example organic to semidetached or embedded) and to underestimate their personnel attributes.

14. The survey team asks the SSC for an annual workplan and for an approved task list by the authorized tasking agency. It then asks the user how often he uses the program, how important the program is, how reliable it must be, and whether his user requirements could be satisfied by replacing the current program with available off-the-shelf software.

15. The most difficult aspect of all this is establishing an agreed baseline of software subsystems which the SSC has the authority to maintain and actually does maintain. Once this has been achieved, the team strives for greatest objectivity by using the following measures:

- A line count of the computer source programs to achieve a reasonable certainty that the reported DSI are correct
- 100% validation of the DB size
FULL JUSTIFICATION FOR UPGRADE OF THE MODE

100% VALIDATION OF ACT

INITIATED BY DAR

PERFORMED BY AUDITEE

LINE COUNT OF ACTUAL CHANGE

VERIFICATION OF ATTRIBUTE VALUES

RELY: (EVIDENCE OF FAILURE ISOLATION, FALLBACK, RECOVERY, DATABASE RECONSTRUCTION, DATA PRIVACY, DATA INTEGRITY, FACILITY SECURITY, HARDWARE RELIABILITY)

DATA: VERIFY DB SIZE (CHECK OF FILES) AND VERIFY DSI

CPLX: REVIEW OF SOFTWARE AND SOFTWARE MAINTENANCE MANUAL

TIME: CHECK LISTING

STORE: CHECK LISTING

VIRT: CHECK SYSTEM HISTORY/FUTURE

TURN: CHECK ACTUAL TURNAROUND TIME

ACAP  VALIDATION OF MAINTAINER'S QUALIFICATIONS
AEXP  INCLUDING ARRIVAL DATE; PREVIOUS EXPERIENCE;
PCAP  EXACT TRAINING; ACAP/PCAP ARE A PROBLEM
VEXP  
LEXP  

MODP: REVIEW SOURCE PROGRAM AND DOCUMENTATION

TOOL: CHECK SYSTEM MANUALS

SCED (N/A)

16. COST DRIVERS FOR THE NEXT YEAR WERE EVENTUALLY AGREED ON BY THE SSC AND THE SURVEY TEAM. A CLEF WAS PREPARED FOR THAT YEAR. SUBSEQUENT YEAR'S CLEFS INCORPORATED EXPECTED CHANGES IN COST DRIVER VALUES.
17. LARGE CHANGES IN HARDWARE UPGRADE, NEW OPERATING SYSTEM SOFTWARE AND DATA BASE MANAGEMENT SYSTEMS ARE IMMINENT OR ARE TAKING PLACE NOW. THESE ARE EFFECTIVELY COVERED BY VIRT. HOWEVER, OTHER TRANSITION OVERHEADS EXIST SUCH AS UPGRADING APPLICATION SOFTWARE SYSTEMS FROM COBOL 68 TO COBOL 74 AND FORTRAN 66 TO FORTRAN 77. THESE MUST BE PROVIDED FOR OUTSIDE THE COCOMO MODEL.

18. LARGE HUMPS IN MANPOWER REQUIREMENTS ALSO EXIST WHERE OLD SOFTWARE SUBSYSTEMS MUST BE RUN IN PARALLEL WITH THEIR REPLACEMENT SOFTWARE FOR AN OVERLAPPING PERIOD.

19. A SENSITIVITY ANALYSIS WAS CARRIED OUT TO FIND SOLUTIONS TO THE "HUMP" PROBLEM AS WELL AS INCREASED MANPOWER REQUIREMENTS PROJECTED BECAUSE OF THE LARGE INCREASES IN SOFTWARE TO BE MAINTAINED. SOME OF THE TEAM'S RECOMMENDATIONS ARE UNLIKELY TO BE ACCEPTABLE IN A NATO ENVIRONMENT BECAUSE LARGE CHANGES IN MANPOWER AND FINANCIAL COMMITMENTS ARE UNLIKELY TO BE APPROVED BY THE NATIONS.

20. ALL OF THIS LEADS TO OUR NEXT SURVEY FOR THE TEAM, SYSTEM 'G'. IT IS A DUAL DEVELOPMENT ENVIRONMENT; SIMULTANEOUS DEVELOPMENT (EVOLUTION) AND A MERGE OF TWO UPDATED BASELINES. IN ADDITION THERE IS THE COMPLICATION OF THE PROLIFERATION OF SOFTWARE SUBSYSTEMS (WITH DIFFERENT VERSIONS) DUE TO HARDWARE (CORE) CONSTRAINTS: 18 SOFTWARE VERSIONS. THE CODE IS OPTIMIZED ASSEMBLER WITH A VERY HIGH OVERHEAD TO SMALL LINES OF CODE CHANGE. ALSO THE GEOGRAPHICAL DISPERSION THROUGHOUT EUROPE CAUSES LOGISTIC AND COMMUNICATION DIFFICULTIES TO THIS SYSTEM. SOME OF OUR QUESTIONS INCLUDE:
HOW DO WE ACCOUNT FOR WORK ON A DAR WHICH FOR SOME REASON IS KILLED BEFORE THE ACTUAL CODE CHANGE TAKES PLACE?

HOW DO WE BUDGET WEEKS OF QA & TEST SOAK FOR CHANGES WITH LIMITED ACT'S.

IN THE INSTANCE WHERE SOFTWARE IS ISSUED IN SEVERAL SLIGHTLY DIFFERENT VERSIONS, HOW DO WE BUDGET THE SLIGHT VERSION MODIFICATIONS TO A BASICALLY COMMON CHANGE?

WHEN AN ORGANIZATION EXTERNAL TO THE ONE BEING SURVEYED IS MODIFYING BASELINES, HOW DO WE BUDGET FOR THE WORK NECESSARY TO UPDATE INTERNAL BASELINES IN LINE WITH THE EXTERNALLY CHANGING BASELINE?

21. MY PURPOSE IN MAKING THIS PRESENTATION WAS TO REPORT AN UNIQUE APPLICATION OF THE COCOMO METHODOLOGY AND TO SOLICIT YOUR CONSTRUCTIVE COMMENTS ON THE WORK WE HAVE DONE AND ON THE PROJECT WE ARE ABOUT TO BEGIN.

22. THIS IS NOT AN OFFICIAL NATO PRESENTATION AND DOES NOT REPRESENT OFFICIAL NATO POLICY. IT IS SIMPLY A STATEMENT OF MY OWN VIEWS.

23. THE ATTACHED FORM IS PROVIDED FOR YOUR CONVENIENCE. YOUR COMMENTS WILL BE MOST APPRECIATED.