1 PRODUCT FACTORS

1.1 REQUIRED SOFTWARE RELIABILITY (RELY)

This is the measure of the extent to which the software must perform its intended function over a period of time. If the effect of a software failure is only slight inconvenience then RELY is low. If a failure would risk human life then RELY is very high.

	Very Low	Low	Nominal	High	Very High	Extra High
RELY	slight inconvenience	low, easily recoverable losses	moderate, easily recoverable losses	high financial loss	risk to human life	

1.2 DATA BASE SIZE (DATA)

This measure attempts to capture the affect large data requirements have on product development. The rating is determined by calculating D/P.

DATA is rated as low if D/P is less than 10 and it is very high if it is greater than 1000.

	Very Low	Low	Nominal	High	Very High	Extra High
DATA		DB bytes/ Pgm SLOC < 10	10 D/P < 100	100 D/P < 1000	D/P 1000	

1.3 PRODUCT COMPLEXITY (CPLX)

Table found at the end of this section provides the new COCOMO® II CPLX rating scale. Complexity is divided into five areas: control operations, computational operations, device-dependent operations, data management operations, and user interface management operations. Select the area or combination of areas that characterize the product or a sub-system of the product. The complexity rating is the subjective weighted average of these areas.

1.4 REQUIRED REUSABILITY (RUSE)

This cost driver accounts for the additional effort needed to construct components intended for reuse on the current or future projects. This effort is consumed with creating more generic design of software, more elaborate documentation, and more extensive testing to ensure components are ready for use in other applications.

	Very Low	Low	Nominal	High	Very High	Extra High
RUSE		none	across project	across program	across product line	across multiple product lines

1.5 DOCUMENTATION MATCH TO LIFE-CYCLE NEEDS (DOCU)

Several software cost models have a cost driver for the level of required documentation. In COCOMO® II, the rating scale for the DOCU cost driver is evaluated in terms of the suitability of the project's documentation to its life-cycle needs. The rating scale goes from Very Low (many life-cycle needs uncovered) to Very High (very excessive for life-cycle needs).

	Very Low	Low	Nominal	High	Very High	Extra High
DOCU	Many life-cycle needs uncovered	Some life-cycle needs uncovered	Right-sized to life-cycle needs	Excessive for life-cycle needs	Very excessive for life-cycle needs	

2 PLATFORM FACTORS

The platform refers to the target-machine complex of hardware and infrastructure software (previously called the virtual machine). The factors have been revised to reflect this as described in this section. Some additional platform factors were considered, such as distribution, parallelism, embeddedness, and real-time operations.

2.1 EXECUTION TIME CONSTRAINT (TIME)

This is a measure of the execution time constraint imposed upon a software system. The rating is expressed in terms of the percentage of available execution time expected to be used by the system or subsystem consuming the execution time resource. The rating ranges from nominal, less than 50% of the execution time resource used, to extra high, 95% of the execution time resource is consumed.

	Very Low	Low	Nominal	High	Very High	Extra High
TIME			50% use of available execution time	70%	85%	95%

2.2 MAIN STORAGE CONSTRAINT (STOR)

This rating represents the degree of main storage constraint imposed on a software system or subsystem. Given the remarkable increase in available processor execution time and main storage, one can question whether these constraint variables are still relevant. However, many applications continue to expand to consume whatever resources are available, making these cost drivers still relevant. The rating ranges from nominal, less that 50%, to extra high, 95%.

	Very Low	Low	Nominal	High	Very High	Extra High
STOR			50% use of available storage	70%	85%	95%

2.3 PLATFORM VOLATILITY (PVOL)

"Platform" is used here to mean the complex of hardware and software (OS, DBMS, etc.) the software product calls on to perform its tasks. If the software to be developed is an operating system then the platform is the computer hardware. If a database management system is to be developed then the platform is the hardware and the operating system. If a network text browser is to be developed then the platform is the network, computer hardware, the operating system, and the distributed information repositories. The platform includes any compilers or assemblers supporting the development of the software system. This rating ranges from low, where there is a major change every 12 months, to very high, where there is a major change every two weeks.

	Very Low	Low	Nominal	High	Very High	Extra High
PVOL		major change every 12 mo.; minor change every 1 mo.	major: 6 mo.; minor: 2 wk.	major: 2 mo.; minor: 1 wk.	major: 2 wk.; minor: 2 days	

3 PERSONNEL FACTORS

3.1 ANALYST CAPABILITY (ACAP)

Analysts are personnel that work on requirements, high level design and detailed design. The major attributes that should be considered in this rating are Analysis and Design ability, efficiency and thoroughness, and the ability to communicate and cooperate. The rating should not consider the level of experience of the analyst; that is rated with AEXP. Analysts that fall in the 15th percentile are rated very low and those that fall in the 95th percentile are rated as very high..

	Very Low	Low	Nominal	High	Very High	Extra High
ACAP	15th percentile	35th percentile	55th percentile	75th percentile	90th percentile	

3.2 PROGRAMMER CAPABILITY (PCAP)

Current trends continue to emphasize the importance of highly capable analysts. However the increasing role of complex COTS packages, and the significant productivity leverage associated with programmers' ability to deal with these COTS packages, indicates a trend toward higher importance of programmer capability as well.

Evaluation should be based on the capability of the programmers as a team rather than as individuals. Major factors which should be considered in the rating are ability, efficiency and thoroughness, and the ability to communicate and cooperate. The experience of the programmer should not be considered here; it is rated with AEXP. A very low rated programmer team is in the 15th percentile and a very high rated programmer team is in the 95th percentile.

	Very Low	Low	Nominal	High	Very High	Extra High
PCAP	15th percentile	35th percentile	55th percentile	75th percentile	90th percentile	

3.3 APPLICATIONS EXPERIENCE (AEXP)

This rating is dependent on the level of applications experience of the project team developing the software system or subsystem. The ratings are defined in terms of the project team's equivalent level of experience with this type of application. A very low rating is for application experience of less than 2 months. A very high rating is for experience of 6 years or more..

	Very Low	Low	Nominal	High	Very High	Extra High
AEXP	2 months	6 months	1 year	3 years	6 years	

3.4 PLATFORM EXPERIENCE (PEXP)

The Post-Architecture model broadens the productivity influence of PEXP, recognizing the importance of understanding the use of more powerful platforms, including more graphic user interface, database, networking, and distributed middleware capabilities.

	Very Low	Low	Nominal	High	Very High	Extra High
PEXP	2 months	6 months	1 year	3 years	6 year	

3.5 LANGUAGE AND TOOL EXPERIENCE (LTEX)

This is a measure of the level of programming language and software tool experience of the project team developing the software system or subsystem. Software development includes the use of tools that perform requirements and design representation and analysis, configuration management, document extraction, library management, program style and formatting, consistency checking, etc. In addition to experience in programming with a specific language the supporting tool set also effects development time. A low rating given for experience of less than 2 months. A very high rating is given for experience of 6 or more years.

	Very Low	Low	Nominal	High	Very High	Extra High
LTEX	2 months	6 months	1 year	3 years	6 year	

3.6 PERSONNEL CONTINUITY (PCON)

The rating scale for PCON is in terms of the project's annual personnel turnover: from 3%, very high, to 48%, very low.

	Very Low	Low	Nominal	High	Very High	Extra High
PCON	48% / year	24% / year	12% / year	6% / year	3% / year	

4 PROJECT FACTORS

4.1 USE OF SOFTWARE TOOLS (TOOL)

Software tools have improved significantly since the 1970's projects used to calibrate COCOMO®. The tool rating ranges from simple edit and code, very low, to integrated lifecycle management tools, very high.

	Very Low	Low	Nominal	High	Very High	Extra High
TOOL	edit, code, debug	simple, frontend, backend CASE, little integration	basic lifecycle tools, moderately integrated	strong, mature lifecycle tools, moderately integrated	strong, mature, proactive lifecycle tools, well integrated with processes, methods, reuse	

4.2 MULTISITE DEVELOPMENT (SITE)

Given the increasing frequency of multisite developments, and indications that multisite development effects are significant, the SITE cost driver has been added in COCOMO® II. Determining its cost driver rating involves the assessment and averaging of two factors: site collocation (from fully collocated to international distribution) and communication support (from surface mail and some phone access to full interactive multimedia).

	Very Low	Low	Nominal	High	Very High	Extra High
SITE: Communications	Some phone, mail	Individual phone, FAX	Narrowband email	Wideband electronic communication.	Wideband elect. comm, occasional video conf.	Interactive multimedia

4.3 REQUIRED DEVELOPMENT SCHEDULE (SCED)

This rating measures the schedule constraint imposed on the project team developing the software. The ratings are defined in terms of the percentage of schedule stretch-out or acceleration with respect to a nominal schedule for a project requiring a given amount of effort. Accelerated schedules tend to produce more effort in the later phases of development because more issues are left to be determined due to lack of time to resolve them earlier. A schedule compress of 74% is rated very low. A stretch-out of a schedule produces more effort in the earlier phases of development where there is more time for thorough planning, specification and validation. A stretch-out of 160% is rated very high.

	Very Low	Low	Nominal	High	Very High	Extra High
SCED	75% of nominal	85%	100%	130%	160%	

Module Complexity Ratings

	Control Operations	Computational Operations	Device-dependent Operations	Data Management Operations	User Interface Management Operations
Very Low	Straight-line code with a few non-nested structured programming operators: DOs, CASEs, IFTHENELSEs. Simple module composition via procedure calls or simple scripts.	Evaluation of simple expressions: e.g., *A=B+C*(D-E)*	Simple read, write statements with simple formats.	Simple arrays in main memory. Simple COTS-DB queries, updates.	Simple input forms, report generators.
Low	Straightforward nesting of structured programming operators. Mostly simple predicates	Evaluation of moderate-level expressions: e.g., *D=SQRT(B**2-4.*A*C)*	No cognizance needed of particular processor or I/O device characteristics. I/O done at GET/PUT level.	Single file subsetting with no data structure changes, no edits, no intermediate files. Moderately complex COTS-DB queries, updates.	Use of simple graphic user interface (GUI) builders.
Nominal	Mostly simple nesting. Some intermodule control. Decision tables. Simple callbacks or message passing, including middleware-supported distributed processing	Use of standard math and statistical routines. Basic matrix/vector operations.	I/O processing includes device selection, status checking and error processing.	Multi-file input and single file output. Simple structural changes, simple edits. Complex COTS-DB queries, updates.	Simple use of widget set.
High	Highly nested structured programming operators with many compound predicates. Queue and stack control. Homogeneous, distributed	Basic numerical analysis: multivariate interpolation, ordinary differential equations. Basic truncation, roundoff concerns.	Operations at physical I/O level (physical storage address translations; seeks, reads, etc.). Optimized I/O overlap.	Simple triggers activated by data stream contents. Complex data restructuring.	Widget set development and extension. Simple voice I/O, multimedia.

	processing. Single processor soft real-time control.				
Very High	Reentrant and recursive coding. Fixed-priority interrupt handling. Task synchronization, complex callbacks, heterogeneous distributed processing. Single-processor hard real-time control.	Difficult but structured numerical analysis: near-singular matrix equations, partial differential equations. Simple parallelization.	Routines for interrupt diagnosis, servicing, masking. Communication line handling. Performance-intensive embedded systems.	Distributed database coordination. Complex triggers. Search optimization.	Moderately complex 2D/3D, dynamic graphics, multimedia.
Extra High	Multiple resource scheduling with dynamically changing priorities. Microcode-level control. Distributed hard real-time control.	Difficult and unstructured numerical analysis: highly accurate analysis of noisy, stochastic data. Complex parallelization.	Device timing-dependent coding, micro-programmed operations. Performance-critical embedded systems.	Highly coupled, dynamic relational and object structures. Natural language data management.	Complex multimedia, virtual reality.

Values

Post Architecture Effort Multipliers	Very Low	Low	Nominal	High	Very High	Extra High
PRODUCT ATTRIBUTES						
RELY Required Software Reliability	Effect of SW failure = slight inconvenience (0.82)	Effect of SW failure = low, easily recoverable losses (0.92)	Effect of SW failure = moderate, easily recoverable losses (1.00)	Effect of SW failure = high financial loss (1.10)	Effect of SW failure = risk to human life/public safety requirements (1.26)	
DATA Database Development Size		Testing DB Bytes/Program SLOC < 10 (0.90)	$10 \leq D/P < 100$ (1.00)	$100 \leq D/P <$ 1000 (1.14)	$D/P \geq 1000$ (1.28)	
CPLX Product Complexity	See Table 14					
DOCU Documentation Match to Life-Cycle Needs	Many life-cycle needs uncovered (0.81)	Some life-cycle needs uncovered (0.91)	Right-sized to life-cycle needs (1.00)	Excessive for life-cycle needs (1.11)	Very excessive for life-cycle needs (1.23)	
RUSE Developed for Reusability		None (0.95)	Across project (1.00)	Across program (1.07)	Across product line (1.15)	Across multiple product lines (1.24)

PLATFORM ATTRIBUTES						
TIME Execution Time Constraint			≤50% use of available execution time (1.00)	70% use of available execution time (1.11)	85% use of available execution time (1.29)	95% use of available execution time (1.63)
STOR Main Storage Constraint			≤50% use of available storage (1.00)	70% use of available storage (1.05)	85% use of available storage (1.17)	95% use of available storage (1.46)
PVOL Platform Volatility		Major change every 12 mo.; Minor change every 1 mo. (0.87)	Major change every 6 mo.; Minor change every 2 wk. (1.00)	Major change every 2 mo.; Minor change every 1 wk. (1.15)	Major change every 2 wk.; Minor change every 2 days (1.30)	

PERSONNEL ATTRIBUTES The personnel attributes are the most misused of the all the effort multipliers. If you do not know who you will be hiring, then assume Nominal which would represent average capability and experience.						
ACAP Analyst Capability	15th percentile (1.42)	35th percentile (1.19)	55th percentile (1.00)	75th percentile (0.85)	90th percentile (0.71)	
PCAP Programmer Capability	15th percentile (1.34)	35th percentile (1.15)	55th percentile (1.00)	75th percentile (0.88)	90th percentile (0.76)	
PCON Personnel Continuity	Annual personnel turnover: 48%/year (1.29)	24%/year (1.12)	12%/year (1.00)	6%/year (0.90)	3%/year (0.81)	
APEX Applications Experience	≤2 months (1.22)	6 months (1.10)	1 year (1.00)	3 years (0.88)	6 years (0.81)	
PLEX Platform Experience	≤2 months (1.19)	6 months (1.09)	1 year (1.00)	3 years (0.91)	6 years (0.85)	
LTEX Language and Tool Experience	≤2 months (1.20)	6 months (1.09)	1 year (1.00)	3 years (0.91)	6 years (0.84)	