MICRO FOCUS

Welcome to:

Introduction to COBOL Programming

Introduction to COBOL Programming

- Class Introductions……
- Your Trainer – Peter Molchan
  - COB100

Introduction to COBOL Programming

- Class Hours
  - Approx 9:00 am. to 4:00 pm.
  - Lunch around 11:30
  - Morning and afternoon break

Introduction to COBOL Programming

- Training Medium
  - Student Workbook
  - Additional Skill-Building Exercises
  - Mainframe Express COBOL Compiler

Introduction to COBOL Programming

- High Level Course Overview
  - COBOL Introduction
  - Structure of a COBOL Program
  - Introduction to Mainframe Express
  - Back to COBOL

Introduction to COBOL Programming

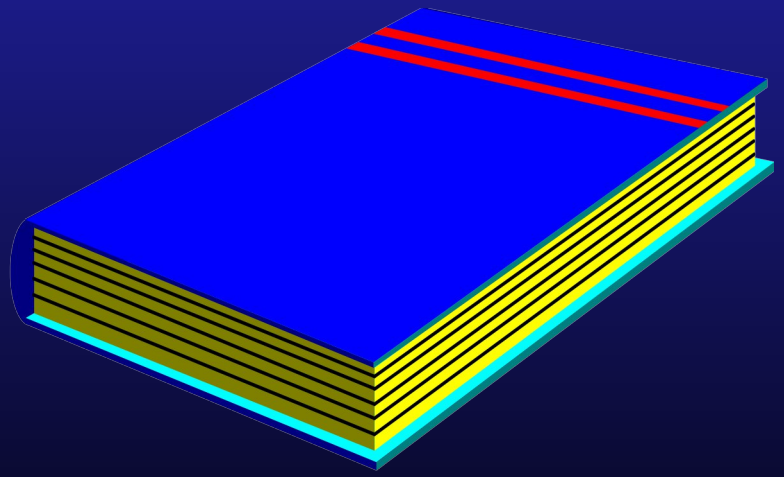
- Course Methodology
  - Lecture
  - Instructor led hands-on instruction
  - Student exercises
  - Case problems
  - Workshop sessions

Introduction to COBOL Programming

- Course Objectives
  - Learn the requirements and syntax of the COBOL language
  - Describe expressions and statements
  - Write File and Data Definition statements
  - Perform Input/Output operations
  - Use arithmetic functions
  - Write basic report programs
  - Use subroutines

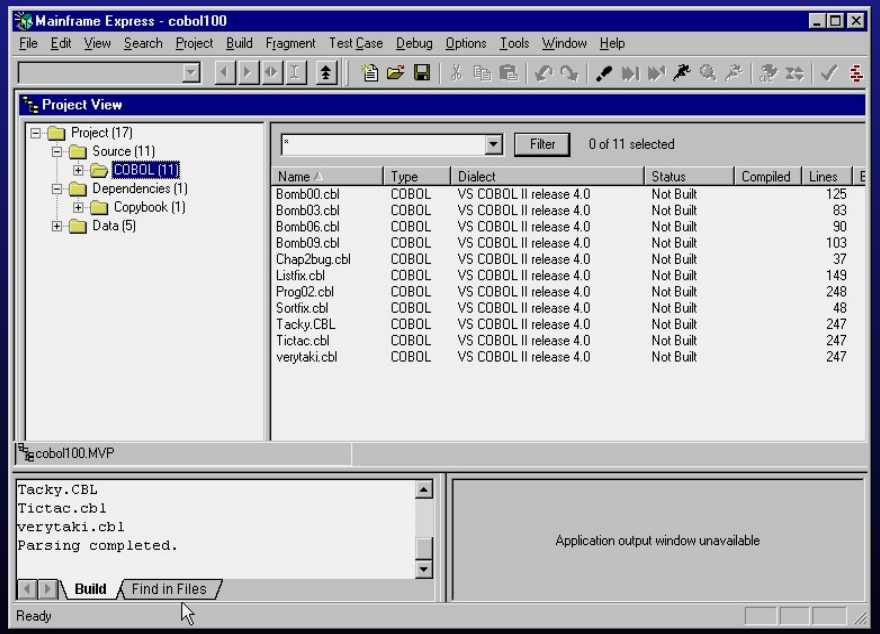
Introduction to COBOL Programming

- Course Manual (Student Workbook) TOC
  - Course Introduction
  - COBOL Overview
  - Program and File Definition
  - COBOL Procedures and Statements
  - Branching
  - Testing and Debugging
  - Validation, Logic, and Arithmetic
  - Elements of Structured COBOL
  - COBOL Reports
  - DBMS Interface **(not covered in public class format)**
  - VS COBOL II differences **(not typically covered in pubilc class format)**

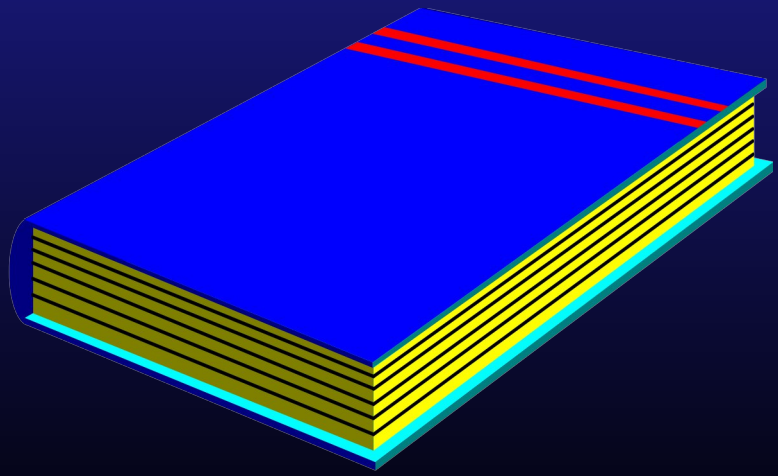


Introduction to COBOL Programming

- Mainframe Express
  - Create/Edit Programs
  - Compile Programs
  - Test/Debug Programs
  - Edit Data Files
  - Control Compiler



Chapter 1 COBOL Overview



1.1 Objectives

After completing this chapter, you will understand the capabilities and syntax of COBOL programs. Specifically, you will be able to:

- Describe the steps of the Programming Life Cycle
- Describe the function of the four COBOL divisions
- List the advantages and disadvantages of COBOL
- Describe the purpose of the COBOL compiler
- Understand the column structure of COBOL

1.2 Topics to be covered:

- Programming life cycle
- What is COBOL?
- Advantages of COBOL
- Limitations of COBOL
- COBOL preparation
- COBOL structure
- COBOL columns
- COBOL lines
- COBOL syntax

Background.....

1.2.1 Programming life cycle

Enterprise Level

Business/data modeling

* Enterprise modeling

Needs analysis

* Feasibility, survey investigation, data gathering & analysis

System design

* Input/output requirements, system controls, databases

Program Development/Maintenance Level

Program development

* Code, compile, link

Testing

* Find the bugs before the bugs find you

Implementation/sign-off

* Conversion, training, auditing, evaluation

Maintenance

* Monitoring, adjustments, upgrades, service requests

1.2.2 What is COBOL?????????

- **Co**mmon **B**usiness **O**riented **L**anguage

- COBOL Roots - Evolution
  - Developed by the Department of Defense in 1959
  - **CO**nference of **DA**ta **SY**stem **L**anguages (CODASYL)
  - Under the guidance of Grace Hopper
  - Conference goals were to develop a language that was:
    - Business Oriented
    - Machine independent
    - English-like
    - Self documenting
  - DOD mandated parameters to software developers
  - Standards were/are maintained/updated by the **A**merican **N**ational **S**tandards **I**nstitute (ANSI)

1.2.3 Advantages of COBOL

- English-like
- Solves Business Problems
- Handles large volumes of data
- Universal and standardized
- Compatible and transportable
- Easy to maintain
- Supports a variety of file organizations

1.2.4 Limitations of COBOL

- Requires a compiler
- English like means statements can be very long
- If unstructured, can be very difficult to maintain/debug
- No Relational DBMS verbs - (SQL must be embedded/pre-compiled)

1.2.5 COBOL Preparation

COBOL code must go through a two step process to become executable

- COMPILE
  - Checks for syntax errors
  - Produces source listing of COBOL
  - Produces diagnostic listing
  - Translates COBOL statements to machine language instructions, producing an object program
- LINK
  - Brings COBOL subroutines into program object code
  - Resolves external references of programs external to program object code
  - Produces load module

Programming Specifics

1.2.6 COBOL Structure

COBOL structure - Formal - 4 Divisions

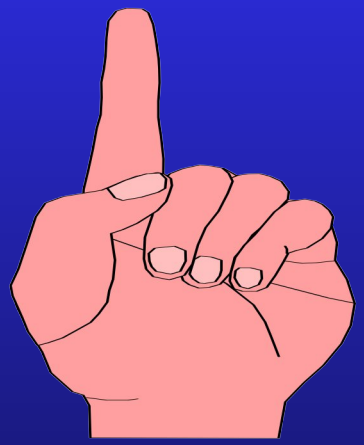
- Identification Division
  - Identifies the program via program name, author, date written, and other pertinent information
- Environment Division
  - Describes computer hardware and external file information
- Data Division
  - Describes input, output, and work files/items
- Procedure Division
  - Contains the logical instructions

1.2.6 COBOL Structure

COBOL structure - Formal - 4 Divisions

```
19 identification division.
20     program-id. tictac.
21 environment division.
22 configuration section.
23     source-computer. ibm-pc.
24     object-computer. ibm-pc.
25 special-names.
26     console is crt.
27 data division.
28 working-storage section.
29 01 tictac-00.
30  02 tictac-q.
95
96 procedure division.
97 play-game section.
98 play-1.
```

1.2.7 COBOL Columns



Coding Rules…….

There are some precise rules governing COBOL coding.

1.2.7 COBOL Columns

```
18*****************************************************************
19 identification division.
20     program-id. tictac.
21 environment division.
22 configuration section.
23     source-computer. ibm-pc.
24     object-computer. ibm-pc.
```

Sequence Numbers

- Columns 1-6

- A Margin
  - Columns 8-11 - Division names, Section names, Paragraph names, File descriptions, Hi-level data items
- B Margin
  - Columns 12-72
- Identification Code
  - Columns 73-80
- Comment/Continuation
  - Column 7
    - Statements are continued in B margin
    - Splitting of literals requires hyphen in column 7 and a leading quote (') in the B-margin

1.2.8 COBOL Lines

```
132          move zero to moves.
133*******  Paragraph added by PTM 9/2/97
134      new-move section.
135          perform get-move with test after until char9 not = 0
136          perform move-check
137          if game not = "stalemate"
```

- Blank lines are OK
- * used in Column 7 for comment lines
- Keywords can be used to control the appearance of your 'post compile' listing
- Line Skips
  - SKIP1
  - SKIP2
  - SKIP3
- Paper Eject - Start New Page for your listing
  - EJECT

1.2.9 COBOL Syntax

Naming conventions apply to:

Data-names

```
 60 01 check-array.
 61     03 check                pic s99      comp  occurs 9 times.
 62 01 xcount                  pic 9(2)     comp.
 63 01 ocount                  pic 9(2)     comp.
 64 01 factor                  pic s9(2)    comp.
 65 01 char                    pic x.
 66 01 char9 redefines char    pic 9.
 67 01 idx                     pic 9(2)     comp.
 68 01 result                  pic 9(2)     comp.
```

Paragraph-names

```
132      move zero to moves.

133*******  Paragraph added by PTM 9/2/97

134 new-move section.
135      perform get-move with test after until char9 not = 0
136      perform move-check
137      if game not = "stalemate"
```

1.2.9 COBOL Syntax

```
60 01 check-array.
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63 01 ocount                  pic 9(2)     comp.
64 01 factor                  pic s9(2)    comp.
65 01 char                    pic x.
66 01 char9 redefines char    pic 9.
67 01 idx                     pic 9(2)     comp.
68 01 result                  pic 9(2)     comp.
```

Rules for forming data-names/paragraph-names

Not permitted

- May NOT be COBOL reserved word (refer to Appendix A in your Manual)
- May NOT contain spaces
- May NOT contain special characters other than hyphen
- May NOT begin or end with hyphen

Permitted

- May contain 1-30 characters
- May consist of alphabet (A-Z), integers (0-9), and hyphens
- Paragraph names may consist entirely of integers, but all other names MUST contain at least one alphabetic character
- SHOULD be different from all other names in THIS program (qualification is possible but not recommended)

1.3 Workshop

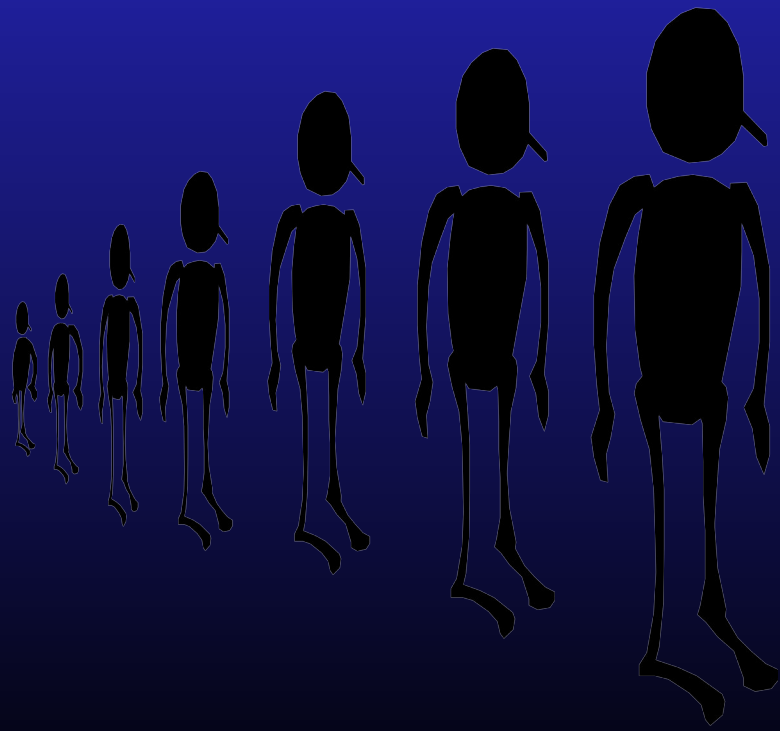
DO

- 1.3.1. Review Questions

Skip

- 1.3.2 Exercise

Take a Break



1.3 Workshop

1.

d. DATA DIVISION

c. IDENTIFICATION DIVISION

b. ENVIRONMENT DIVISION

a. PROCEDURE DIVISION

2.

c. A Margin

d. B Margin

e. Identification code

b. Comments/continuation

a. Sequence numbers

3.

X OUTPUT RECORD X PAY$

X RATE/5 52-PICKUP

QUANTITY-ON-HAND X SUPER*

X TOTAL#RECORDS GROSS-PROFITS

INPUT-REC X PAY_TABLE

1.3 Workshop

4. COBOL Compiler

- Checks for syntax errors
- Produces source listing of COBOL
- Produces diagnostic listing
- Translates COBOL statements to machine language instructions, producing an object program

5. COBOL Advantages

- English-like
- Solves Business Problems
- Handles large volumes of data
- Universal and standardized
- Compatible and transportable
- Easy to maintain
- Supports a variety of file organizations

6. COBOL Disadvantages

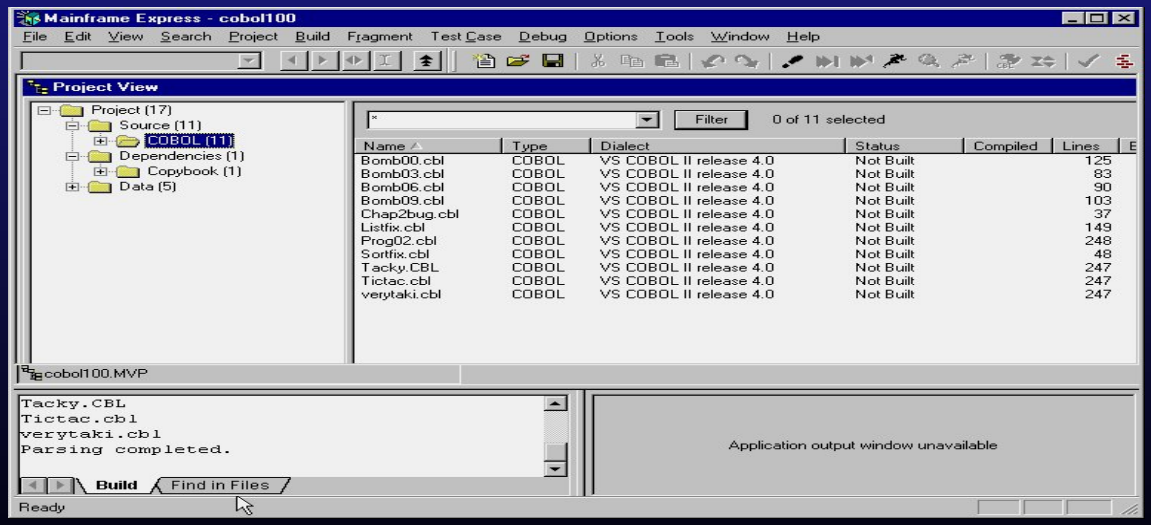
- Requires a compiler
- English like means statements can be very long
- If unstructured, can be very difficult to maintain/debug
- No Relational DBMS verbs - (SQL must be embedded/pre-compiled)

Review……

At this point we should be able to:

- Describe the steps of the Programming Life Cycle
- Describe the function of the four COBOL divisions
- List the advantages and disadvantages of COBOL
- Describe the purpose of the COBOL compiler
- Understand the column structure of COBOL

Using the Micro Focus Mainframe Express

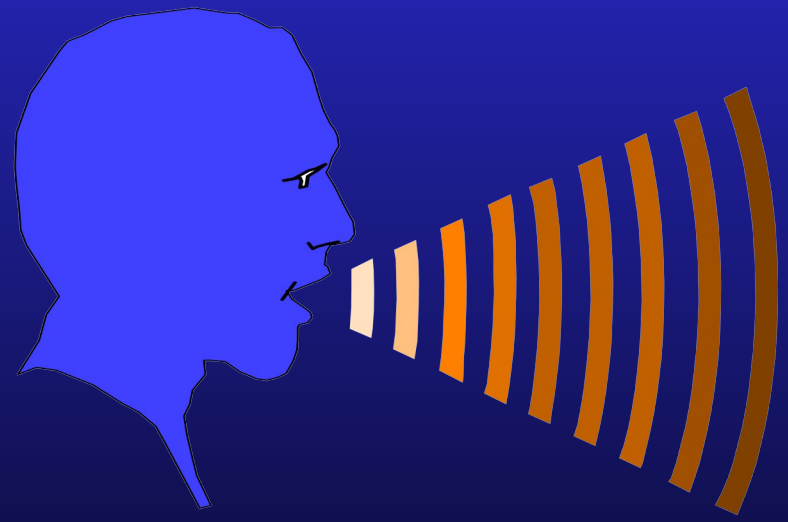


What is the Mainframe Express????

An integrated , graphical COBOL application development toolset which allows you to create, maintain and support:

- Production mainframe applications
- PC-based and GUI-Client/Server applications

COBOL Compiler-Language Dialects



- OSVS
- VSCII
- COBOL370
- SAA-COBOL
- Object COBOL

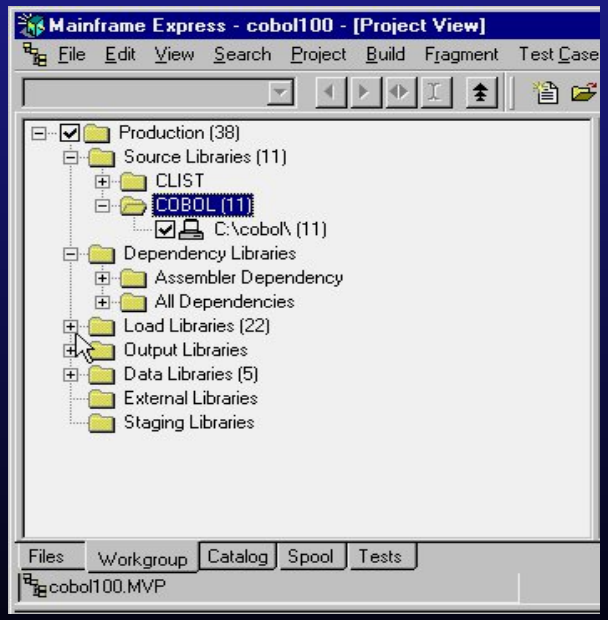
COBOL Development Tools

- ***Edit***
- ***Check***
- ***Animate***

- Editor
- Compiler
- Testing Environment

Project Organization

Workgroups are used to group programs, data and related files together for easy access to the testing environment



Shall we try it out???

Let's Edit, Check and Animate a program……

- Start the MFE
- Open our COB100 Project
  (C:\COBOL\COBOL100.MVP)
- Expand Source Folder and highlight COBOL
- Start our Edit
  - Right Click on TICTAC.CBL
  - Click Edit
  - After the program loads, click Check/Compile
- Shut Down the Workbench

Shall we try it out???

Let's Edit, Check and Animate a program……

- Select Run from the Debug Menu
- Select the TSO Tab
- Enter CALL TICTAC

Now its your turn…….

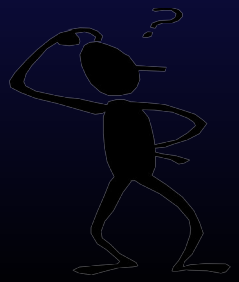
Repeat the test of TICTAC.CBL on your own……..

Let's code something new……..

- In the COBOL100 Project
  - From the File Menu select New
  - Select Source File
- You should be in an Edit Session - Code the following……..

```
1 IDENTIFICATION DIVISION.
2 ENVIRONMENT DIVISION.
3 DATA DIVISION.
4 PROCEDURE DIVISION.
```

- When you finish coding, click
  - Save as ,under the File Menu
  - Right mouse button in the edit area and Select Add to Project
  - Check
- Clean-up any errors……ask for Help if needed…..



Let's debug a program……..

- Start the MFE
- Load COBOL100 Project
- Start our Edit/Compile Session
  - Double Click on TACKY.CBL to edit
  - Click Check/Compile
- When you encounter the first compiler error, click Zoom to finish the Compile
- Fix the Program Bug
- Recheck the Program

Quiz time…….

When using Mainframe Express, the cycle of Edit, Compile Test is referred to as:

- Edit, Compile, Debug

Name a few of the existing COBOL compiler dialects.

- OSVS, VSCII, ANSI85, SAA-COBOL, Object COBOL

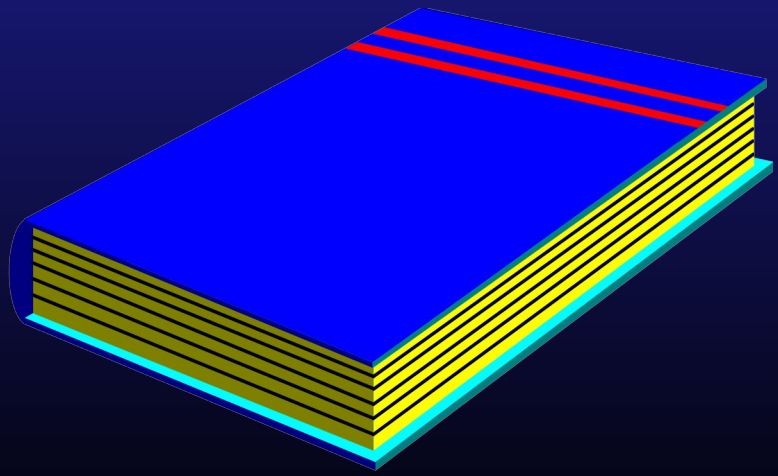
The program VERYTAKI.CBL has several errors in it. See if you can rise to the challenge and get a clean compile…….

Review……

At this point we should be able to:

- Describe the steps of the Programming Life Cycle
- Describe the function of the four COBOL divisions
- List the advantages and disadvantages of COBOL
- Describe the purpose of the COBOL compiler
- Understand the column structure of COBOL
- ***Use the Micro Focus Workbench to Edit, Syntax Check and Animate a program***

Chapter 2 Program and File Definitions



2.1 Objectives

After completing this chapter, you will understand the three COBOL divisions used to identify the program and its files (Identification, Environment, and Data Division). Specifically, you will be able to:

- Code an identification division
- Code an environment division
- Code a data division
- Tell whether statements belong in the A-margin or B-margin
- Write a record description for a file
- Process literals and figurative constants
- Describe the mainframe COBOL compiler

2.2 Topics to be covered:

- Identification division
- Environment division
- Data division
- File description
- PICTURE clause
- USAGE clause
- VALUE clause
- Literals and figurative constants
- Copy statement
- COBOL compiler and options

2.2.1 Identification Division

Documents program name and origin

- PROGRAM-ID
  - Required
  - 1-30 characters
  - Only first 8 used to uniquely identify program
- AUTHOR
- INSTALLATION
- DATE-WRITTEN
- DATE-COMPILED
- SECURITY

2.2.1 Identification Division

Example:

```
000100 IDENTIFICATION DIVISION.
000200 PROGRAM-ID. HL2COB1.
000300 AUTHOR. ALFRED E NEWMAN SALES X-9876.
000400 INSTALLATION. COMPANY B.
000500 DATE-WRITTEN. JANUARY, 1990.
000600 DATE-COMPILED.
000700 SECURITY. UNCLASSIFIED.
```

Note the use of periods

2.2.1 Work Assignment

Use Maineframe Express to create a new file called PROGRAM1.CBL

Code the example (in your book). Use applicable notations for Program-Id, etc.

```
000100 IDENTIFICATION DIVISION.
000200 PROGRAM-ID. PROGRAM1.
000300 AUTHOR. ALFRED E NEWMAN SALES X-9876.
000400 INSTALLATION. COMPANY B.
000500 DATE-WRITTEN. JANUARY, 1990.
000600 DATE-COMPILED.
000700 SECURITY. UNCLASSIFIED.
```

Check your program for syntax errors

2.2.2 Environment Division

made up of 2 sections

CONFIGURATION SECTION

Describes computer on which program is compiled and executed

SOURCE-COMPUTER

OBJECT-COMPUTER

INPUT-OUTPUT SECTION

Relates each program file with external hardware device via

FILE-CONTROL statement

SELECT program-file ASSIGN TO jcl-external-name

jcl-external-name

- class indicator (2)
- organization indicator (1)
- external name (1-8)

2.2.2 Environment Division

Example:

```
000800 ENVIRONMENT DIVISION.
000900 CONFIGURATION SECTION.
001000 SOURCE-COMPUTER.  IBM-370.
001100 OBJECT-COMPUTER.  IBM-370.
001200 INPUT-OUTPUT SECTION.
001300 FILE-CONTROL.
001400 SELECT SALES-FILE-IN ASSIGN TO UT-S-SALESIN.
001500 SELECT REPORT-FILE-OUT ASSIGN TO UT-S-RPTOUT.
```

UT - Unit Tape

S - Sequential

2.2.2 Work Assignment

Add the following code to PROGRAM1.CBL

```
000800 ENVIRONMENT DIVISION.
000900 CONFIGURATION SECTION.
001000 SOURCE-COMPUTER.  IBM-370.
001100 OBJECT-COMPUTER.  IBM-370.
001200 INPUT-OUTPUT SECTION.
001300 FILE-CONTROL.
001400 SELECT SALES-FILE-IN ASSIGN TO UT-S-SYSUT1.
```

Check your program for syntax errors

****** Syntax errors for missing FD's are OK for now**

2.2.3 Data Division

Contains detailed information about all data used by your program

FILE SECTION

- describes external data

WORKING-STORAGE SECTION

- describes internal data

2.2.3 Data Division/File Section

FILE SECTION

FD File Descriptors (Logical File Definitions) - one for each file in the program

```
FD SALES-FILE-IN                (Describes the Data file named in the SELECT
LABEL RECORDS ARE STANDARD      (Throwback to tape storage - records were
                                 for disk storage)
RECORDING MODE IS F             (fixed/variable record length)
RECORD CONTAINS 80 CHARACTERS   (# of bytes in the record)
BLOCK CONTAINS 0 RECORDS        (# of records in a block of records)
DATA RECORD IS SALES-RECORD.    (data name of the record)
01 SALES-RECORD    PICTURE X(80).    (refers back to the DATA-RECORD data-name
```

2.2.3 Data Division

Example:

```
001600 DATA DIVISION.
001700 FILE SECTION.
001800 FD SALES-FILE-IN
001900     LABEL RECORDS ARE STANDARD
002000     RECORDING MODE IS F
002100     RECORD CONTAINS 80 CHARACTERS
002200     BLOCK CONTAINS 0 RECORDS
002300     DATA RECORD IS SALES-RECORD.
002400 01 SALES-RECORD          PICTURE X(80).
002500 WORKING-STORAGE SECTION.
002600 77 END-OF-FILE-SWITCH PICTURE X VALUE 'N'.
002700 01 PRINT-CONTROL.
002800     05 LINE-COUNTR       PICTURE 9(2) VALUE 99.
002900     05 PAGE-COUNTR       PICTURE 9(4) VALUE 0.
003000     05 LINES-PER-PAGE    PICTURE 9(2) VALUE 60.
```

2.2.3 Work Assignment

Add the following code to PROGRAM1.CBL

```
001600 DATA DIVISION.
001700 FILE SECTION.
001800 FD SALES-FILE-IN
001900     LABEL RECORDS ARE STANDARD
002000     RECORDING MODE IS F
002100     RECORD CONTAINS 78 CHARACTERS
002200     BLOCK CONTAINS 0 RECORDS
002300     DATA RECORD IS SALES-RECORD.
002400 01 SALES-RECORD          PICTURE X(78).
002500 WORKING-STORAGE SECTION.
002600 77 END-OF-FILE-SWITCH PICTURE X VALUE 'N'.
002700 01 PRINT-CONTROL.
002800     05 LINE-COUNTR       PICTURE 9(2) VALUE 99.
002900     05 PAGE-COUNTR       PICTURE 9(4) VALUE 0.
003000     05 LINES-PER-PAGE    PICTURE 9(2) VALUE 60.
```

2.2.4 Variable Length Records

RECORDING MODE IS V

RECORD CONTAINS largest #

DATA RECORDS ARE

Example:

```
DATA DIVISION.
FILE SECTION.
FD SALES-FILE-IN
LABEL RECORDS ARE STANDARD
RECORDING MODE IS V
RECORD CONTAINS 90 CHARACTERS
BLOCK CONTAINS 0 RECORDS
DATA RECORDS ARE        REGION-1-RECORD
                        REGION-2-RECORD
```

2.2.5 Describing Data

- ***File: group of related records***
- File description area (FD)
  - Code an FD for each file referenced by the program
  - FD coded in the A margin
  - File name coded in the B margin
  - File Parameters coded in the B margin
  - File name must match SELECT statement in Environment Division
- ***Record: group of related fields***
- Record name
  - Follow each FD (external record description)
  - Also appear in Working-Storage (internal to the program)
  - Described as an 01 level
  - Code in A margin
- ***Field: item used for one piece of data***
- Field within record
  - 02-49 level
  - Data Name or FILLER may be used
  - Code in B margin
- Elementary item
  - One field
  - Code in A margin
  - 01 LINE-COUNTR PICTURE 9(2) VALUE 99.
- Group item
  - Higher level item composed of one or more lower level elementary items
  - 01 PRINT-CONTROL.

    05 LINE-COUNTR PICTURE 9(2) VALUE 99.

    05 PAGE-COUNTR PICTURE 9(4) VALUE 0.

2.2.5 Describing Data - Example

```
1        8    12
         A    B
```

```
001600 DATA DIVISION.
001700 FILE SECTION.
001800 FD  SALES-FILE-IN
001900       LABEL RECORDS ARE STANDARD
002000       RECORDING MODE IS F
002100       RECORD CONTAINS 80 CHARACTERS
002200       BLOCK CONTAINS 0 RECORDS
002300       DATA RECORD IS SALES-RECORD.
002400 01  SALES-RECORD            PICTURE X(80).
002500 WORKING-STORAGE SECTION.
002600 77 END-OF-FILE-SWITCH PICTURE X VALUE 'N'.
002700 01 PRINT-CONTROL.
002800      05 LINE-COUNTR          PICTURE 9(2) VALUE 99.
002900      05 PAGE-COUNTR          PICTURE 9(4) VALUE 0.
003000      05 LINES-PER-PAGE       PICTURE 9(2) VALUE 60.
```

2.2.5 Data Representation

- A discussion about how data is represented
  - binary
  - hex
  - bits and bytes
  - halfwords and words
    - 2bytes, 4 bytes
  - etc……..

2.2.5 Data Representation

CODE ASSIGNMENTS (Cont'd)

Code Tables (Cont'd)

Dec.	Hex	Graphics and Controls BCDIC	EBCDIC(1)	ASCII	7-Track Tape BCDIC(2)	Card Code EBCDIC	Binary
192	C0	?	{		B A 8 2	12-0	1100 0000
193	C1	A	A	A	B A 1	12-1	1100 0001
194	C2	B	B	B	B A 2	12-2	1100 0010
195	C3	C	C	C	B A 2 1	12-3	1100 0011
196	C4	D	D	D	B A 4	12-4	1100 0100
197	C5	E	E	E	B A 4 1	12-5	1100 0101
198	C6	F	F	F	B A 4 2	12-6	1100 0110
199	C7	G	G	G	B A 4 2 1	12-7	1100 0111
200	C8	H	H	H	B A 8	12-8	1100 1000
201	C9	I	I	I	B A 8 1	12-9	1100 1001
202	CA		SHY			12-0-2-8-9	1100 1010
203	CB					12-0-3-8-9	1100 1011
204	CC					12-0-4-8-9	1100 1100
205	CD					12-0-5-8-9	1100 1101
206	CE					12-0-6-8-9	1100 1110
207	CF					12-0-7-8-9	1100 1111
208	D0	!	}		B 8 2	11-0	1101 0000
209	D1	J	J	J	B 1	11-1	1101 0001
210	D2	K	K	K	B 2	11-2	1101 0010
211	D3	L	L	L	B 2 1	11-3	1101 0011
212	D4	M	M	M	B 4	11-4	1101 0100
213	D5	N	N	N	B 4 1	11-5	1101 0101
214	D6	O	O	O	B 4 2	11-6	1101 0110
215	D7	P	P	P	B 4 2 1	11-7	1101 0111
216	D8	Q	Q	Q	B 8	11-8	1101 1000
217	D9	R	R	R	B 8 1	11-9	1101 1001
218	DA					12-11-2-8-9	1101 1010
219	DB					12-11-3-8-9	1101 1011
220	DC					12-11-4-8-9	1101 1100
221	DD					12-11-5-8-9	1101 1101
222	DE					12-11-6-8-9	1101 1110
223	DF					12-11-7-8-9	1101 1111
224	E0	≠	\		A 8 2	0-2-8	1110 0000
225	E1		NSP			11-0-1-9	1110 0001
226	E2	S	S	S	A 2	0-2	1110 0010
227	E3	T	T	T	A 2 1	0-3	1110 0011
228	E4	U	U	U	A 4	0-4	1110 0100
229	E5	V	V	V	A 4 1	0-5	1110 0101
230	E6	W	W	W	A 4 2	0-6	1110 0110
231	E7	X	X	X	A 4 2 1	0-7	1110 0111
232	E8	Y	Y	Y	A 8	0-8	1110 1000
233	E9	Z	Z	Z	A 8 1	0-9	1110 1001
234	EA					11-0-2-8-9	1110 1010
235	EB					11-0-3-8-9	1110 1011
236	EC					11-0-4-8-9	1110 1100
237	ED					11-0-5-8-9	1110 1101
238	EE					11-0-6-8-9	1110 1110
239	EF					11-0-7-8-9	1110 1111
240	F0	0	0	0	8 2	0	1111 0000
241	F1	1	1	1	1	1	1111 0001
242	F2	2	2	2	2	2	1111 0010
243	F3	3	3	3	2 1	3	1111 0011
244	F4	4	4	4	4	4	1111 0100
245	F5	5	5	5	4 1	5	1111 0101
246	F6	6	6	6	4 2	6	1111 0110
247	F7	7	7	7	4 2 1	7	1111 0111
248	F8	8	8	8	8	8	1111 1000
249	F9	9	9	9	8 1	9	1111 1001
250	FA					12-11-0-2-8-9	1111 1010
251	FB					12-11-0-3-8-9	1111 1011
252	FC					12-11-0-4-8-9	1111 1100
253	FD					12-11-0-5-8-9	1111 1101
254	FE					12-11-0-6-8-9	1111 1110
255	FF		EO			12-11-0-7-8-9	1111 1111

1. Two columns of EBCDIC graphics are shown. The first gives IBM standard U.S. bit pattern assignments. The second shows the T-11 and TN text printing chains (120 graphics).
2. Add C (check bit) for odd or even parity as needed, except as noted.
3. For even parity, use CA.

2.2.6 Picture Clause

- PICTURE (PIC) describes data TYPE and LENGTH
  - A - alphabetic
  - 9 - numeric
  - X- alphanumeric
  - V- implied decimal
  - S - sign (optional) used to capture +,- values

Examples:

2.2.7 Usage Clause

- USAGE (optional) describes how data is stored
  - INDEX
    - Used in table handling
  - DISPLAY
    - One character per byte ("print format") - default
  - COMPUTATIONAL (COMP) - binary
    - 1st position contains operational sign
    - 1-4 digits = 2 bytes (halfword)

2.2.7 Usage Clause

- USAGE (optional) describes how data is stored

  - COMPUTATIONAL-1 (COMP-1) - short precision floating point
    - 4 bytes (fullword)
  - COMPUTATIONAL-2 (COMP-2) - long precision floating point
    - 8 bytes (doubleword)
  - COMPUTATIONAL-3 (COMP-3) - packed decimal format
    - 2 digits per byte

2.2.8 Display Data

PIC X(3) VALUE ‘ABC’ USAGE DISPLAY.
PIC X(3) VALUE ‘ABC’.

| C1 | C2 | C3 |

PIC 9(4) VALUE 1234 USAGE DISPLAY.
PIC 9(4) VALUE 1234.

| F1 | F2 | F3 | F4 |

PIC S9(4) VALUE 1234 USAGE DISPLAY.
PIC S9(4) VALUE 1234.

| F1 | F2 | F3 | C4 |

2.2.9 Packed data

PIC 9(3) VALUE 123 USAGE COMP-3.
PIC 9(3) VALUE 123 COMP-3.

| 12 | 3F |

PIC S9(4) VALUE 123 USAGE COMP-3.
PIC S9(4) VALUE 123 COMP-3.

| 00 | 12 | 3C |

PIC S9(4) VALUE -123 USAGE COMP-3.
PIC S9(4) VALUE -123 COMP-3.

| 00 | 12 | 3D |

2.2.10 Binary Data

PIC 9(4) VALUE 10 USAGE COMP.
PIC 9(4) VALUE 10 COMP.

| 00 | 0A |

PIC 9(4) VALUE 123 USAGE COMP.
PIC 9(4) VALUE 123 COMP.

| 00 | 7B |

2.2.11 VALUE Clause

Optional

- initializes memory
- Can't be used in file section
- Only used with elementary items

EXAMPLES

```
01 PRINT-CONTROL.
   05 LINE-COUNTER        PIC 9(2) VALUE 99.
   OS PAGE-COUNTER        PIC 9(4) VALUE ZERO.
   05 LINES-PER-PAGE      PIC 9(2) VALUE 60.
   01 HEADlNG-l.
   05 FILLER              PIC X(30) VALUE SPACES.
```

2.2.12 Numeric Literals

- Syntax
  - 1-8 digits
  - Optional decimal (any position except last)
  - Optional sign (+ or -) - must be first
    * if sign not used, compiler assumes value is positive
  - Cannot enclose in quotes

- Storage

```
05 PAGE-COUNTER PIC 9(4) VALUE 10.
 | F0 | F0 | F1 | F0 |
05 BILL-AMOUNT       PIC 9(3)V99 VALUE 10.
 | F0 | F1 | F0 | F0 | F0 |
05 CASH-VALUE PIC S9(3)V99 VALUE +14.32.
 | F0 | F1 | F4 | F3 | C2 |
05 DEBIT-AMOUNT PIC S9(3)V99 VALUE -394.13
```

2.2.13 Alphanumeric Literals

- Syntax
  - 1-120 characters
  - enclosed in quotes
  - may contain any character (except quotes)
- Storage

```
05 HEADING-3 PIC X(8) VALUE 'PAGE'.

    | P  | A | G | E |    |    |    |    |
| D7 | C1 | C7 | C5  | 40 | 40 | 40 | 40 |
05 HEADING-NUMBER PIC X(7) VALUE '898'.
```

2.2.14 Figurative Constants

- Compiler generated - *refer to course manual*

- do not enclose in quotes

LOW-VALUE
LOW-VALUES
HIGH-VALUE
HIGH-VALUES
SPACE
SPACES
QUOTE
QUOTES
ZERO
ZEROS
ZEROES
A L 'x'

2.2.15 COPY statement

. Brings in externally stored COBOL code at compile time

- Usually Data Division
- Saves time
- Reduces errors
- Pulled in at compile time from COBOL libraries
- Must use ‘LIB' compiler option and //SYSLIB DD statement
- COPY module-name

```
COPY SALEREC.
```

2.2.16 Compiling procs for JCL

- Purpose - check syntax of COBOL statements
  - COBUC
    - Compile using standard COBOL compiler
  - COB2UC
    - Compile using VS COBOL 11 compiler

2.2.17 Compiler files

- STEPLIB
  - Points to location of compiler program
- SYSIN
  - Compiler input - points to data set containing COBOL source
- SYSUT1
  - Compiler workspace needed by compiler
- SYSPRINT
  - Compiler report output - storage map, listings, messages
- SYSLIN
  - Object data set as output from compiler
- SYSPUNCH
  - Object data set as output from compiler
- SYSLIB
  - Optional user COBOL source libraries (for COPY command)

2.2.18 Compiling your program - mainframe

- ISPF Option 5 (BATCH)
  - Choose which COBOL compiler you want
  - Fill in a valid job card
  - Fill in options (remembered from session to session)
  - Press ENTER or PF3, as instructed to submit batch compile
  - Browse the output using Option S (SDSF)

2.2.19 Compiler Options

- Controls the outputs of the compiler
- Specified in the PARM= field of your JCL
- In Micro Focus, right click on the program to access check/compile options
  - Note: for animating (testing) a program in this class you will have to add the following compiler directive (option) to access data files
    - **ASSIGN 'EXTERNAL'**