SYNDIA USER'S GUIDE

by

W.E. Cory

Technical Report No. 176

August 1979

This work was supported by the Joint Services Electronics Program under Contract N-00014-75-C-0601 and the Tektronix Foundation.
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ABSTRACT

This report describes how to use the Syndia/Syngra system available at SU-SORE. This system accepts a BNF-like grammar specification and automatically generates syntax diagrams on a Tektronix graphics terminal. Syndia is the major component of this system; Syngra acts as an interface between Syndia and the SUDS2 graphics editor. Syndia performs no ambiguity or consistency checks on the BNF input.

This report assumes that the reader is familiar with BNF and syntax diagram representations of grammars.

INDEX TERMS: Syndia, automatic syntax diagram generation, BNF, Backus-Naur Form, language documentation
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1.0 INTRODUCTION

Syndia is a Pascal program which reads a modified-BNF description and writes instructions for drawing syntax diagrams on a hypothetical plotter. One drawing is generated for each BNF production.

Syndia is now available at SU-SCORE and is interfaced to the SCORE graphics editor SUDS2 by a second program Syngra. This manual describes the use of Syndia and Syngra along with the input format required by Syndia.

Syndia was originally written by J. Spillman and was modified and extended by Karl Josef Bucher at Eidg. Techische Hochschule in Zuerich. Larry Paulson (Stanford SAIL) modified Syndia to run under TOPS-10. Warren Cory made further modifications and has set up the current working version on SU-SCORE.

This manual (minus diagrams) is on-line at SU-SCORE in DOC:SYNDIA.MAN. The original Syndia files for all the examples in this manual are

PS:<CSL.DA.SYNDIA>SME1,
PS:<CSL.DA.SYNDIA>SME2,
PS:<CSL.DA.SYNDIA>SME3, and
PS:<CSL.DA.SYNDIA>SYNDIA.SYN.
A Syndia BNF description contains three major sections. The first is the parameter section. In this section, the user specifies what output should be generated, the width of the plots, etc.

The second section, the symbol declaration section, is optional. Here the user may define the character string values of identifiers. This is useful for two reasons:

1. The user may define short abbreviations for long character strings.
2. The character string value is always treated as an identifier, even if it contains meta-characters or keywords. This will be explained in more detail later.

The final section contains the BNF productions. This section may also include modifications which affect the layout of individual diagrams.

These three sections are described in turn in Sections 4, 5, and 6, following a discussion of identifiers and constants in Section 3. The use of Syndia and Syngra is explained in Section 7. Finally, a complete example appears in Section 8.
3.0 SYNDIA CHARACTER SET, IDENTIFIERS, AND CONSTANTS

3.1 Character Set

Syndia uses the following character set:

- Upper case letters A–Z
- Digits 0–9
- Special characters: " # $ % ` ( ) * + , - . / : ; < > = ? @ [ ] \ ^ _

The remaining printing 7-bit ASCII characters are "folded" (upper-cased) on input according to the table below. Hence, Syndia will not recognize the characters "", "[", "]", "|", or "-", and these characters should not appear in the input. Syndia will expand tabs (CTRL-I) to blanks; other non-printing characters are ignored.

<table>
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<th>ASCII CHARACTERS:</th>
<th>&quot;FOLDED&quot; TO:</th>
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<tr>
<td>Lower case letters a–z</td>
<td>Upper case letters A–Z</td>
</tr>
<tr>
<td>`</td>
<td>@</td>
</tr>
<tr>
<td>(</td>
<td>{</td>
</tr>
<tr>
<td>)</td>
<td>}</td>
</tr>
<tr>
<td></td>
<td>\</td>
</tr>
<tr>
<td>_</td>
<td>^</td>
</tr>
</tbody>
</table>

DEL (ASCII code 177 octal)
3.2 Identifiers

Identifiers in Syndia are used as names for character strings. The syntax for identifiers in Syndia is more flexible than in most languages, as the following examples show:

**VALID IDENTIFIERS:**

```plaintext
**STAR**
. +1
EXPRESSION
/
META%((),/:;=]
```

The following restrictions apply to identifier names:

1. Identifiers longer than 40 characters are truncated to 40 characters.
2. Blanks cannot be embedded in identifiers.
3. Identifiers cannot contain the characters "<" or ">".
   Example:
   TERM>                       is equivalent to   TERM > ;
   that is, ">" is not part of the identifier.

4. An identifier cannot begin with a digit or a meta-character. The meta-characters are listed below:
   < > / : ; % $ \ [ ] ( )
   Example:
   [BOX]                      is equivalent to   [ BOX] :
   "[" is not part of the identifier (but "]" is!).

5. An identifier cannot be a keyword, nor can it begin with a keyword followed by a non-alphanumeric character. The alphanumeric characters are the letters A-Z, the digits 0-9, and underscore "_". The keywords are listed below:
   APPEND  ENDMODIFY  PAGewidth
   BNF     ENDPARAM    PARAMETER
   BREAK   EXCHANGE    PLOT
   BREAKOPT LABELS     PLOTLABEL
   CHARS   MAIN        PRINTBNF
   CM      MODIFY      PRINTPLOT
   DIANUMBER OZERO     SYM
   Example:
   PARAMETER-LIST          is equivalent to PARAMETER
   -LIST ; that is, keyword
   PARAMETER followed by
   identifier -LIST. But
   PARAMETER_LIST
   is a single identifier.

   Note that meta-characters (except "<" and ">") which follow an identifier but are not intended to be part of the identifier name MUST BE SEPARATED FROM THE IDENTIFIER BY SPACE OR END-OF-LINE. Also, the string "PLOT(15.0)" is not an identifier (since PLOT is a keyword); it is equivalent to "PLOT ( 15 , 0 )".

   Blanks may not be embedded in keywords.
3.3 Constants

In Syndia, constants are unsigned integers or fixed point real numbers. In real numbers, at least one digit must precede the decimal point. Blanks may not be embedded in numbers.

Examples:
0
1.7
0.1683
22001
2.
Syndia generates two output files: a lineprinter listing showing the input with other optional output, and a second file containing instructions for the hypothetical plotter. In the parameter section, the user may specify up to eight parameters which indicate the nature of this output. These are discussed in turn:

4.1 PRINTPLOT

PRINTPLOT specifies that the lineprinter listing include plots of the several diagrams, drawn with standard ASCII characters for output on an ordinary lineprinter. This is useful if it is inconvenient to obtain plotter drawings every time Syndia is run during the BNF debugging process. The integer argument specifies the default width in columns to be used for the plots. (If this default value is too small for some diagram, then the smallest possible width will be used.)
4.2 PRINTBNF

PRINTBNF specifies that Syndia include in the listing the final BNF resulting after any symbol substitutions have been carried out. The integer argument gives the width in columns of the BNF listing. Syndia makes no attempt to "pretty print" this listing.

4.3 PAGewidth

PAGewidth gives the width in columns of the page on which the listing is to be printed. The number given does not include the first column, which Syndia always sets to blank ' ' for Fortran carriage control. When no PAGewidth parameter is present, a page width of 130 is assumed.

Syndia will allow the widths given with PRINTPLOT and PRINTBNF to exceed the page width. In such cases, Syndia will split the output at the page boundary.

4.4 PLOT

The PLOT parameter specifies that instructions for the hypothetical plotter be output. The first number argument gives the default width in centimeters for the syntax diagrams. (15 cm. is just under 6 inches.) The second argument gives the width of the characters to be used in the diagrams. Syndia will NOT check to ensure that the character size specified is not too big.

The plotter drawings will be scaled to resemble the lineprinter drawings obtained by PRINTPLOT. If PRINTPLOT is not specified, the plotter drawings will resemble lineprinter plots 100 columns wide.

There are two possible special values for the second argument. If the second argument is zero, then Syndia will compute the largest character size it can use for each drawing.

The other possible special value for the second argument is equals-sign "=". This value causes Syndia to use the same character size used in the lineprinter plots, scaled by the difference in sizes between the lineprinter and plotter drawings. This character size will be somewhat smaller than the size computed if the second argument is zero.

***NOTE*** The current version of the graphics editor at SCORE handles only a single character size, 0.1683 cm. Syndia will automatically select this size unless it is
forced (by excessive drawing density) to choose a smaller size. It is therefore recommended that the user set the second PLOT argument to zero (or, perhaps, to 0.1683).

4.5 DIANUMBER

A diagram generated by Syndia is ordinarily labeled only with the nonterminal name from the left hand side of the corresponding production. If DIANUMBER is specified, then Syndia will precede this label with the integer preceding the production in the BNF section (see Section 6).

4.6 OZERO

If OZERO is specified, then Syndia will change all 0's ("oh") to 0's ("zero") and vice versa in the lineprinter and plotter drawings. This is useful, for example, if the plotting software slashes 0's ("oh") while the user wants to slash 0's ("zero").

4.7 LABELS

In its internal representation, each syntax diagram has all of its nodes numbered, where a node is a corner or intersection. The user may refer to these node numbers in modifications to alter the layout of the diagram. LABELS specifies that these node numbers will appear in the lineprinter drawings generated by PRINTPLOT.

4.8 PLOTLABEL

PLOTLABEL specifies that the node numbers mentioned above will appear in the plotter drawings generated by PLOT.
5.0 SYMBOL DECLARATIONS

Normally, the value of an identifier is the same as its name. For example, the identifier REGISTER has as its value the character string 'REGISTER'. However, identifiers may be assigned different values in the symbol declaration section. When these identifiers appear later in the BNF, they are replaced by their values, the character strings given in the declarations. The replacement strings are always treated as identifiers, even if they contain embedded blanks, meta-characters, or keywords. String replacement is not recursive; for example, after

\[ B = 'C', \]
\[ A = 'B', \]

the value of A is 'B', not 'C'. Note that any printing character may be used as the delimiter. The replacement string, like all identifiers, must not exceed 40 characters in length.

Examples:

\[ \text{SYM } L = '( ', \text{ R } = ')', \]
\[ P% = '%', \text{ C } = '.', \]
\[ \text{SHORT } = / \text{LONGER CHARACTER STRING}/; \]
The BNF section contains the productions for which syntax diagrams are to be generated. This section may also contain modifications which alter the layout of specified diagrams. Productions and modifications may be mixed in any order.

Syndia draws one syntax diagram per production. It performs absolutely no checking to ensure that the grammar being described makes any sense; the sole function of Syndia is to draw the diagrams specified, nonsensical or not.

The integer preceding each production appears before the label in the syntax diagram if the DIANUMBER parameter is given. In addition, the integers serve as "handles" for the modifications. All modifications preceded by a given integer are applied to all productions preceded by the same number. (The same number may precede several productions.) Note that the integer in front of a production or modification marks the end of the preceding production.
6.1 Productions

Syndia production syntax is quite similar to normal BNF. Syndia has special notation for $-$closure, +-closure, and lists, which allows the efficient generation of aesthetic diagrams. The syntax is illustrated by examples below in which Syndia's notation is contrasted with standard BNF.

In the simplest production, the right-hand side is a non-empty sequence of terminals and/or nonterminals. The left- and right-hand sides may be separated either by "::=" or by "=":

<EXAMPLE_1> ::= B <C> <D E> #STAR

Example 1

Note the different shapes of the boxes for terminals and nonterminals. Multiple productions for the same nonterminal may be written as a single production with the several alternatives separated by slashes:
BNF:  
<EXAMPLE_2> ::= B
<EXAMPLE_2> ::= <C> + <D>
<EXAMPLE_2> ::= XYZ

Syndia:  
<EXAMPLE_2> ::= B / <C> + <D> / XYZ

Optional strings in Syndia are enclosed in square brackets:
BNF:  
<EXAMPLE_3> ::= B <C>
<EXAMPLE_3> ::= B X Z <C>

Syndia:  
<EXAMPLE_3> ::= B [ X Z ] <C>

Plus-closure is denoted by enclosing text in "%" and "\":
BNF:  
<EXAMPLE_4> ::= Q
<EXAMPLE_4> ::= <EXAMPLE_4> Q

Syndia:  
<EXAMPLE_4> ::= % Q \n
Star-closure is indicated by adding a "$" to the above notation:
BNF:  
<EXAMPLE_5> ::= null
<EXAMPLE_5> ::= <EXAMPLE_5> ***

Syndia:  
<EXAMPLE_5> ::= % $ *** \n
Finally, Syndia has a special list notation which may be regarded as an extension of \$-closure:
BNF:  
\[
\text{EXAMPLE}_6 ::= \text{LIST ELEMENT} \\
\text{EXAMPLE}_6 ::= \text{EXAMPLE}_6 \text{ LIST SEPARATOR} \text{ LIST ELEMENT} \\
\]

Syndia:  
\[
\text{EXAMPLE}_6 ::= % \text{LIST ELEMENT} $ \text{LIST SEPARATOR} \text{ \textbackslash} \\
\]

\text{EXAMPLE}_6

---

The above constructs may be combined and nested to any degree, with parentheses used where necessary to achieve the proper grouping:

\[
\text{EXAMPLE}_7 ::= % A ( B | C ) / % D \text{ \textbackslash} E \text{ \textbackslash} F ) \text{ \textbackslash} \\
\]

\text{EXAMPLE}_7

---

6.2 Modifications

\text{MODIFICATION}

---

Seven different modifications are available for altering the appearance of a diagram.
CHARS

The CHARS modifier sets the width in columns of the lineprinter drawing for the associated production(s). If CHARS is not specified, then Syndia will use the default width given with PRINTPLOT (or 100 if PRINTPLOT was not specified). Recall from Section 4 that the width chosen for the lineprinter drawing can affect the appearance of the plotter drawing.

CM

The CM modifier sets the width in centimeters of the plotter drawings for the associated production(s). If CM is not specified, then Syndia will use the default width given with PLOT.

EXCHANGE, MAIN, and APPEND

The EXCHANGE, MAIN, and APPEND modifiers specify horizontal paths which are to be moved in some fashion. The horizontal paths are identified by the numbers assigned to their left-most nodes. These node numbers may be obtained by specifying LABELS or PLOTLABEL as described in Section 4. After modifications, the node numbers may change, but these new node numbers are NOT valid for use in new modifications. The user should always use the node numbers from the unmodified diagram.

The EXCHANGE modifier identifies two horizontal paths which are to be interchanged.

BEFORE EXCHANGE(3,7)

\[ \begin{array}{c}
1 \\
5 \\
7 \\
9 \\
2 \\
4 \\
3 \\
6 \\
8 \\
\end{array} \]

AFTER EXCHANGE(3,7)

\[ \begin{array}{c}
1 \\
5 \\
7 \\
9 \\
2 \\
4 \\
3 \\
6 \\
8 \\
\end{array} \]
The **MAIN** modifier specifies a horizontal path which is to be drawn in line with the entry and exit lines at the end branch points.

**MAIN(p1,...,pk)** is equivalent to **"MAIN(p1);...;MAIN(pk)"**.

The **APPEND** modifier specifies a horizontal path which is to be drawn in line with the horizontal path above it.

**APPEND(p1,...,pk)** is equivalent to **"APPEND(p1);...;APPEND(pk)"**.

**BREAK**

The **BREAK** modifier identifies a node where a single horizontal path should be broken into two levels. The node numbers should always be taken from the unmodified drawing.
"BREAK(p1,...,pk)" is equivalent to "BREAK(p1);...;BREAK(pk)".

BREAKOPT

The BREAKOPT modifier causes Syndia to automatically insert BREAK's where required to make the lineprinter diagram fit in the width specified in PRINTPLOT (or 100 columns if PRINTPLOT was not specified).
7.0 HOW TO USE SYNDIA

Any file name used by Syndia, Syngra, or the graphics editor must be a valid TOPS-10 file specification in which the name has not more than six characters and the extension has not more than three characters. A TOPS-10 device spec may precede the name, and a directory spec, if present, must be in the form of a PPN following the extension. (The PPN for a directory may be found by the TRANSLATE command.) Hence, in its most general form, a valid file specification has the format

```
dev:name.ext(ppn)
```

The procedure for running Syndia at SU-SCORE follows:

1. Prepare your Syndia input file.

2. Give the EXEC command to run Syndia:

```
@SYNDIA
```

3. Syndia will prompt for INPUT, OUTPUT, and MAINPLOT file names. The INPUT file is the file prepared in Step 1. The OUTPUT and MAINPLOT files will contain the lineprinter listing and the hypothetical-plotter instructions, respectively.

If you follow any file name in this step with "/SYNGRA", as in

```
INPUT    = SYNTAX.IN/SYNGRA
```

then Syndia will automatically start Syngra if no errors are found in the input. If the input contains errors, Syndia will print a message "ERROR(S) IN INPUT" at the terminal. The error messages may then be found in the OUT put listing file.

4. If you did not specify "/SYNGRA" when you ran Syndia, then you may start Syngra by giving the EXEC command:

```
@SYNGRA
```

5. Syngra will prompt for the MAINPLOT file name. Respond with the same MAINPLOT file name you gave Syndia. If you follow this file name with "/EDIT", then Syngra will automatically start the graphics editor when it is done.

6. The function of Syngra is to convert the MAINPLOT output from Syndia into a form readable by the graphics editor. In general Syngra will generate many output files. Each output file corresponds to one screenful of diagrams on the Tektronix 4014. Syngra automatically puts as many diagrams as it can in one screenful; conversely, if one diagram is too big to fit on the screen, Syngra will split it into as many parts as necessary, with enough overlap between parts to allow easy cut-and-paste.

During execution, Syngra will do three things at the
terminal.

1. Syngra will print the sequence number and name of each diagram as it is encountered in the input.

2. Syngra will prompt for output file names as required. When choosing the output file names, remember that the graphics editor will be expecting input files with the extension ".INT" or ".SYM".

3. Syngra will flag the appearance of character sizes not supported by the graphics editor. If you specified a character width of zero in the PLOT parameter, then this error condition indicates a diagram that is too crowded. This may be corrected by adding modifications, splitting the production into several shorter productions, increasing the plotter diagram width, or (in some cases) by DECREASING the lineprinter diagram width.

7. You must be logged in at the Tektronix 4014 terminal in order to run the graphics editor. If you did not specify "/EDIT" when you ran Syngra, then you may start the editor by giving the EXEC command:

```
2SU5S2
```

The use of the editor is described in a manual in the ERL terminal room next to the 4014 terminal. The manual is also on-line at SU-SCORE in DOC:SUDS2.MAN. The use of a small subset of the available commands will suffice to generate the diagrams.
8.0 EXAMPLE FROM ZUERICH SHOWING USE OF SYNDIA AT SU-SCORE

TYPE OUT THE INPUT FILE

@TYPE PS:<CSL.DA.SYNDIA>SME3
PARAMETER
PRINTPLOT(50);
PLOT(10.0);
PAGEWIDTH(50);
LABELS;
PRINTBNF(50);
OZERO
ENDPARAM

BNF
SYM
A1 = / /, L( = /(/, R) = /)/, SLASH = ./.;
1 < T1 > ::= % B$ C \n1 < T2 > ::= % B $ C \n20 < T3 > ::= [ < A1 > % L( C R) \ ]
1 MODIFY CHAR$40) ENDMODIFY
3 MODIFY APPEND(5) ENDMODIFY
3 <T3 A1 L( T5 R)> = A / B / C
5 <T6> ::= < A > SLASH <B> SLASH/
3 MODIFY MAIN(7) ENDMODIFY
0

GET PS:<CSL.DA.SYNDIA> PPN

TRANSLATE PS:<CSL.DA.SYNDIA>
PS:<CSL.DA.SYNDIA> (IS) PS:[4,1007]
NOW RUN SYNDIA AND SYNGRA

SYNDIA
INPUT = FS: SME3[4,1007]/SYNGRA
OUTPUT = SME3.LIS
MAINPLOT = SME3.SYO
**STARTING SYNGRA**
MAINPLOT = SME3.SYO
NEW OUTPUT FILE STARTING IN DIAGRAM 1:
STARTING DIAGRAM NO. 1: T1
STARTING DIAGRAM NO. 2: T2
STARTING DIAGRAM NO. 3: T3
STARTING DIAGRAM NO. 4: T3 ( T5 )
STARTING DIAGRAM NO. 5: T6
EXIT

LOOK AT THE OUTPUT LISTING

SYNDIA VERSION JUNE 4, 1979 / SU-SCORE

PARAMETER
  PRINTPLOT(50):
  PLOT(10,0):
  PAGewidth(50):
  LABELS:
  PRINTBNF(50):
  OZERO
ENDPARAM

BNF
SYM
  A1 = / /, L( = /(/, R) = /), SLASH = ./
  1 < T1 > ::= % B* C \n  1 < T2 > ::= % B $ C \n  20 < T3 > ::= [ < A1 > % L( C R) ]
  1 MODIFY CHARS(40) ENDMODIFY
  3 MODIFY APPEND(5) ENDMODIFY
  3 <T3 A1 L( T5 R)> = A / B / C
  5 <T6> ::= < A > SLASH < B > SLASH/
  3 MODIFY MAIN(7) ENDMODIFY
  0
TABLE OF ABBREVIATIONS

A1  
L(  
R)  
SLASH  

BACKUS - NAUR - FORM

1 < T1 > ::= % 'B$' 'C' \  
2 < T2 > ::= % 'B' * 'C' \  
3 < T3 > ::= [ < > % '(' 'C' ')') \  
4 < T4 ( T5 ) > ::= 'A' / 'B' / 'C'  
5 < T6 > ::= < A > '/' < B > 'SLASH/'

END OF BACKUS-NAUR-FORM

T1

5 6
-<------------------
I  A
V  I
1 3 -- 7 -- 4 2
---I---*B**---*C*---
   --

T2

5 6
-<-*C*--
I  A
V  I
1 3 -- 4 2
-----I---*B*---I---
T3

```
7 <-------------------- 8
  I  A
  V   I
1 3 ---- 5 -- 9 -- 10 -- 6 4 2
```

T3 (T5)

```
11 -- 13
   A  I
   I  V
  5 6 -- 7 8 -- 9 10
```

```
A   I
I  12 14
I  I  V
1 3 -- 4 2
```

T6

```
1 -- 3 -- 4 -- 5 -- 2
```

```
IAI --- */--- IBI --- *SLASH/* ---
```
Plotter diagrams may now be obtained by running SUDS2.
9.0 SYNDIA SYNTAX DIAGRAMS

The Syntax diagrams for Syndia are repeated here for reference.

**IDENTIFIER**

```
NON-META CHAR.
```

**NON-META CHAR.**

```
LETTER

1
2
3
4
5
6
7
8
9
```

**INTEGER**

```
DIGIT
```

**NUMBER**

```
DIGIT
```

```
`.`
```

```
DIGIT
```

**SYNDIA USER'S GUIDE**

**DMF INPUT**

1. **PARAMETER SECTION**
   - **DMF**
   - **SYMBOL DECLARATIONS**

2. **PARAMETER SPECIFICATION**
   - **PARAMETER**
   - **PARAMETER SPECIFICATION**
   - **ENDPARM**

3. **PARAMETER SPECIFICATION**
   - **PRINTPLOT**
   - **INTEGER**
   - **NUMBER**
   - **DIMNUMBER**
   - **OZERO**
   - **LABEL**
   - **PLOT**
   - **NUMBER**
   - **PLOT**
   - **NUMBER**
   - **PLOT**

**SYMBOL DECLARATIONS**

1. **SYM**
   - **SYMBOL DEFINITION**

2. **SYMBOL DEFINITION**
   - **IDENTIFIER**
   - **DELIMITER**
   - **CHAR. STRING NOT CONTAINING DELIMITER**
   - **SAME DELIMITER**

**DELIMITER**

- **ANY PRINTING CHARACTER**
This report describes how to use the Syndia/Syngra system available at SU-Score. This system accepts a BNF-like grammar specification and automatically generates the major component of this system; Syngra acts as an interface between Syndia and the SUDS2 graphics editor. Syndia performs no ambiguity or consistency checks on the BNF input.

This report assumes that the reader is familiar with BNF and syntax diagram representations of grammars.
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