

# DERIVE interfaces with Word and Multi Edit

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## Abstract

Two packages are presented establishing the DERIVE interfaces with Word and Multi Edit (ME). These interfaces are better than the DERIVE for Windows interface because Word or ME provides more tools for the text editing, viewing, and printing than DERIVE. If a user calls, e.g., Word, types a formula, marks it, and clicks on a menu item or presses a hot key, then the corresponding DERIVE result appears at the cursor position. All the DERIVE functions are accessed through the Word or ME menu items. The interfaces can be easily customized. This is important in teaching, where all unnecessary menu items must be hidden because they divert the attention of students or even frighten them by unknown mathematical terms. The nice color worksheets can be made for solving problems. Complicated programs with symbolic calculations can be created using the Word or ME macro languages and run by a simple key press. The interfaces can protect documents and DERIVE itself from illegal copying.

# Introduction

In this communication I discuss the user interfaces with DERIVE for DOS and DERIVE for Windows. I present new computer programs that make the work with DERIVE more effective and pleasant. The programs offer also new useful options.

An important part of DERIVE is its built-in Editor. It receives the user key presses and mouse clicks and represents them by the symbol lines in the DERIVE window. Another part of DERIVE is its engine. It reads a selected symbol line in the window and transforms it in a new symbol line. The transformation is specified by the user command. DERIVE has also a menu. Some of the menu items are represented in a toolbar in the DERIVE for Windows.

I think that the Editor, the windows, the menu, and the toolbar should be improved because they do not meet the current standards for the user interfaces. Here are some comments in this respect.

## Menu of DERIVE for Windows

**File.** The difference between “Save As ...” and “Write To...” is unclear. It would be better to include all options from “Write To...” in “Save As...” It is desirable to add saving as the LaTeX source and/or in the Rich Text Format (RTF). The option “Change Directory...” is useful but it conflicts with the standard “Working Directory” option in the Windows “Properties” menu.

**Edit.** It is strange that we have not standard “Cut”, “Copy”, and “Past.” Operation “Expression...” produces a new line rather than modifies the selected one. Operation “Go to Expression...” is not useful because its result can be obtained by a mouse click. Operation “Remove” is unnecessary because its result can be obtained by pressing the Del key. Operation “Move” can be justified by the absence of “Cut” and “Past” only. Operation “Renummer” is justified by an incomplete

work of the “Move.” It would be more natural to combine “Move” and “Renumber” in one operation.

I like the separation of the copy operation in “Copy Expressions” and “Mark and Copy”, but the better names for them could be “Copy as Text” and “Copy as Picture.” It is bad that the font information is lost when “Copy Expressions” sends a selected part of the DERIVE window to the Clipboard. It is strange that selecting and copying are two different operations with expressions but go together in the “Mark and Copy” option.

The menu item “Edit” usually includes an “Undo”, “Find”, and “Replace” operations. It is a pity that DERIVE does not offer such standard options.

**Toolbar.** The standard toolbar of DERIVE for Windows is useful. A drawback is that we cannot configure it or create other toolbars.

A general menu drawback is that it cannot be customized. A cus-

tomization is necessary because many DERIVE operations (e.g., matrix operations) cannot be accessed via the standard menu. It is a pity that hot keys for the DERIVE operations are not user-defined.

## **The DERIVE windows**

The main problem with the DERIVE windows is that we cannot access them directly except for the line manipulation and copying. If something must be written in a window, then the “Author” command line must be used. Such an indirect procedure is unique now and looks strange.

Another problem is a poor quality of formulas in the DERIVE windows. The examples are the square roots and the systems of equations. It is a pity that nothing in the windows can be highlighted by varying font shapes and/or colors.

It is often useful to zoom in or zoom out the screen but DERIVE does not offer such operations.

We can see that DERIVE offers less text processing options than the Windows 3 NotePad. I think that a good CAS must offer at least as many text processing options as the Windows.3 Write or the Windows 95 WordPad. Maple V R4, Mathcad 5, Mathematica 2.2, Matlab 4, MuPad 1.41, Scientific WorkPlace, and Scientific Notebook meet such a minimum requirement while DERIVE does not. I show below that the DERIVE interface can be easily improved to meet the requirement. Moreover, a high-level programming language and many new useful options will be available to control DERIVE after such an improvement.

## **1. Creating a new user interface for DERIVE**

I think that DERIVE for DOS has a good engine and the only thing to do is to improve the user interface with it. Respecting the copyrights,

I cannot change anything in the DERIVE executable file. Therefore, I must address the engine via the standard DERIVE interface. Fig. 1 shows the new communication structure.

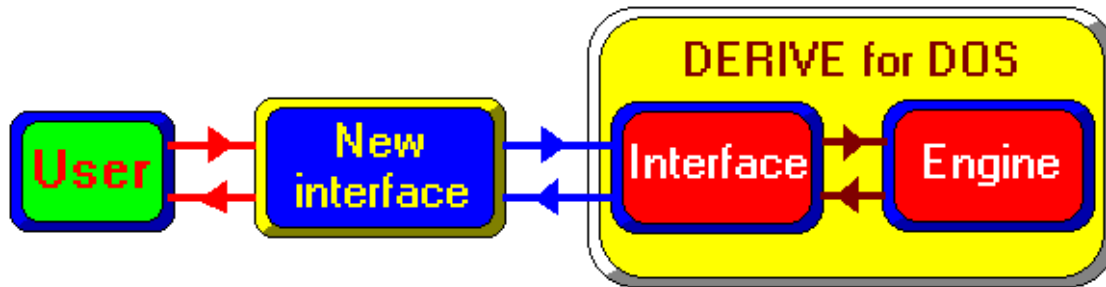


Fig. 1. A modification of the DERIVE user interface.

Two new interfaces are available. The first is based on Microsoft Word and the second is based on Multi Edit of American Cybernetics, Inc. They are called Word-DERIVE and ME-DERIVE interfaces below.



## 2. Word-DERIVE interface

The Word-DERIVE interface is established by a package containing several macros included in the template `wdinterf.dot`, the file `wdinterf.exe`, and some auxiliary files. The package size is about 50K. The files of the package must not be modified except for the files `data.0` and `derive.ini`. The template `wdinterf.dot` may be saved under another name and then modified. Thus, the files `data.0`, `derive.ini`, and `wdinterf.dot` enable to customize all options of the Word-DERIVE interface.

If a Word document is created using the template `wdinterf.dot`, then all DERIVE functions are available directly in the Word window. The next page shows an example of such document. The toolbars are hidden there to save the place.

### Formulas created using the EQ-field codes

Note the proper presentation of the square root in this formula.

$$\int_a^b \sqrt{\frac{1-x}{x^2+1}} (\cos x + e^x) \, dx$$

Note the proper presentation of the system of equations and the indices in this formula.

[illegible]

In the previous page, we can note that the menu items contain no underlined letters. Such letters are usually used in the combination with Alt key to call the corresponding menu items. For example, the letter F is usually underlined in the menu item “File” and pressing Alt+f makes the File operations accessible. We can get the same result by clicking on the item. Therefore, in the Word-DERIVE interface, the hot keys Alt+something are used to insert the special symbols rather than to call the menu items. For example, Alt+a inserts alpha, Alt+b inserts beta,..., Alt+f inserts phi,..., Alt+G inserts the capital gamma,... . Such insertions are possible because wdinterf.dot contains special macros. The user can change the makro-to-key assignments and assign menu items and/or toolbar buttons to the macros. Of course, new macros can be created and saved and some macros can be deleted in a renamed copy of the template wdinterf.dot. The complete list of all hot keys defined in wdinterf.dot enters the documentation accompanying the Word-DERIVE interface. See your Word manual for more details about macros, menus,

toolbars, and key assignments.

In the previous page, we can see that the formulas in the Word windows look better than in the DERIVE windows. These formulas are created using MS Word EQ-field codes (see the Word help for the detailed information about the MS Word fields and their codes). The EQ-field codes constitute a very simple but effective language that enables us to built up complex mathematical expressions. Some expressions look a little bit better if they are created using the MS Equation Editor or the MathType by Design Science, Inc. These programs represent formulas by complicated codes of the MS Word EQUATION objects. The Word-DERIVE interface can read such codes if the RTF to LaTeX converter by TCI Software Research is installed. In any case, the Word-DERIVE interface can write the formulas as the MS Equation Editor and the MathType, but I cannot see an advantage of using such a complicated method. If a high-quality formula representation is required, then the document should be saved in the RTF format and converted in the La-

TeX format using the RTF to LaTeX converter. Printing such a LaTeX file, we obtain a professional quality document. The present document is prepared in LaTeX. The Conclusion contains some formulas.

It is possible to use the DERIVE language for representing the formulas. Then the results of mathematic operations are returned in the DERIVE language also. This is the fastest way to use the Word-DERIVE interface. The interface can transform a formula written in the DERIVE language in the EQ-field form. This can be done, e.g., at the end of work on the document.

If a portion of text is selected and a DERIVE command is specified using menu, toolbar, or a hot key, then DERIVE returns the result. Some examples of such dialog are presented in the next two pages. The toolbars are hidden there to save the place. The results returned by DERIVE are represented in red.

## Using DERIVE codes

Computing the slope of  $x^3$  via a limit from above

$$\lim (((x + h)^3 - x^3) / h, h, 0) = 3x^2$$

A limit involving extra variables

$$\lim ((a^x - b^x) / x, x, 0) = \ln(a) - \ln(b)$$

An illustration of the chain rule

$$\text{dif}(\sin(x^3), x) = 3x^2 \cos(x^3)$$

A partial derivative

$$\text{dif}(x^2 y^3, y) = 3x^2 y^2$$

An antiderivative by substituting a  $x^3 + b \rightarrow u$

$$\text{int}(x^2 \cos(ax^3 + b), x) = x^3 \cos(ax^3 + b) / 3$$

A definite integral for  $x$  going from  $a$  to  $b$

$$\text{int}(x^2, x, a, b) = b^3/3 - a^3/3$$

An integral having an infinite integration limit

$$\text{int}(1/x^2, x, a, \text{inf}) = 1/a$$

## Using EQ-field codes

Note that the notation is mathematically correct.

**Limit.**

$$\lim_{x \rightarrow 0} \frac{\sin(x)}{x} = 1$$

**Derivatives.**

$$\frac{d}{dx} \sin(x) = \cos(x) \quad \frac{\partial^2}{\partial x \partial y} \sin(xy) = \cos(xy) - xy \sin(x)$$

**Indefinite integral.** The constant is added automatically.

$$\int x^3 dx = \frac{x^4}{4} + C$$

**Determinant.**

$$\begin{vmatrix} 1 & 2 \\ 3 & 4 \end{vmatrix} = -2$$

**Hot keys.** The examples shown on two previous pages are obtained using the Simplify command. The predefined hot key for such command is Alt+ . The hot keys for over operations are Ctrl+e for Expand, Ctrl+f for Factor, Ctrl+l for soLve etc. The user can change these hot keys. The commands can also be specified using the menu selections or the toolbar buttons.

**Menu.** The DERIVE selection of the wdinterf.dot menu contains the following options: Author, Simplify, Approximate, Declare ..., Figure ..., Number ..., Function ..., Vector ..., Matrix ..., Equations ..., Vector Field ..., Sample ..., and Transform in ... . We can see that the DERIVE operations are grouped according to the objects the operations can be applied to. (Another menu structure is described in the next section.) In a copy of wdinterf.dot having different name, the user can modify the menu.



The submenus of the DERIVE selection are

**Declare...**

Variable

Function

Vector

Matrix

Edit data

State

**Figure ...**

Draw

Area

Volume

Triangle solution

**Number ...**

Factor

Function of

Continued on the next page

Function ...	Sequence ...	Vector ...	Matrix ...
Value	Limit	Length	Determinant
Factor	Sum	Multiply by	Trace
Expand	Product		Transpose
Limit			Inverse
Derivatives			Function of
Taylor polynomial			Gauss form
Graph			Char. polynomial
Antiderivative			Eigenvalues
Integral			Eigenvectors
Gradient			
Laplacian			

Continued on the next page

Equations ...	Vector Field ...	Sample ...	Transform in ...
Solve symbolically	Divergence	Mean	asic
Solve numerically	Curl	Mean square	C
Iterations	acobi matrix	Deviation	FORTTRAN
	Scalar potential	Fit	LaTeX
	Vector potential		Pascal

**Toolbars.** The template wdinterf.dot contains 3 toolbars in addition to the standard Word toolbars. These toolbars are designed after analyzing the toolbars of DERIVE for Windows, Maple V, MathCAD, Mathematica, MathType, MS Equation Editor, Scientific Notebook, and Scientific WorkPlace. The first toolbar facilitates typing the mathematical expressions. All symbols and the EQ-field codes are accessible via this toolbar. The second toolbar contains the buttons corresponding to the DERIVE operations. It complements the menu. The buttons of the third toolbar correspond to the most frequently used operations. In a copy of wdinterf.dot having different name, the user can modify the toolbars and add other toolbars.

Here are the advantages of using Word-DERIVE interface instead of working directly with DERIVE for Windows.

1. High quality documents can be created because all MS Office and Windows facilities are available. In particular, we can use “Cut”, “Copy”, and “Paste” operations, “Undo”, “Find”, “Replace”, line warping, changing fonts and colors, and text formatting.
2. Direct access to any part of window is available.
3. Windows standard data and object exchanges with other applications are available.
4. Menu, toolbars, and hot keys are fully customizable.
5. High-level programming language (Visual Basic for MS Word or Visual Basic for MS Word ) is available.

If MS Word and DERIVE for Windows are not linked by the Word-DERIVE interface, then formulas and graphs can be inserted in a Word document via the Clipboard. But the quality of formulas is low and the programming language cannot be used in such case.

### **3. ME-DERIVE interface**

The ME-DERIVE interface is designed for an efficient work on high-quality color documents containing mathematical expressions and graphics. The interface is established by a package containing the macros `derive_k.mac`, `derive_u.mac`, `resource.mac`, and some auxiliary files. The package size is about 50K. The files of the package can be modified except for the file `derive_k.mac`. This enables the user to customize all options of the ME-DERIVE interface.

The Multi Edit has the following advantages over MS Word:

1. Last 15–20 inputs are remembered and can be easily repeated with necessary modifications
  2. More effective “Find”, “Replace”, and “lock” operations
  3. More configuration options
  4. Extension specific configuration
  5. Context-dependent and extension-specific Help that can be easily customized
- . Advanced macro language.
  - . Moderate system requirements.

We note, however, that the Multi Edit is not a W–SIW–G application. Therefore, the ME-DERIVE interface is designed for a professional work rather than for education.

The ME-DERIVE dialog is in the DERIVE language. The resulting documents are in the ASCII format. They can be the LaTeX sources. A LaTeX to RTF converter is included in the package. Therefore, the Word documents can also be created using the ME-DERIVE interface. The highest quality is obtained if the LaTeX documents are converted in the PostScript format using one of the public-domain converters that can be downloaded from the CTAN servers.

**Menu.** The DERIVE selection of the ME-DERIVE menu contains the options Author, Simplify, Approximate, Declare ..., Algebra ..., Geometry ..., Calculus ..., Prob. Stat., Graph ..., Solve ..., Transform in ..., and Write to ... . We can see that the DERIVE operations are grouped according to their mathematical nature. The user can change everything in the DERIVE selection.

The submenus of the DERIVE selection are



### Declare ...

Variable  
Function  
Vector  
Matrix  
Edit data  
State

### Algebra ...

Function  
Expand  
Factor  
Sum  
Product  
Determinant  
Trace  
Transpose  
Inverse  
Gauss form  
Char. polynomial  
Eigenvalues  
Eigenvectors

### Geometry ...

Figure  
Triangle solution  
Area  
Volume

Continued on the next page

**Calculus ...**

Limit  
Derivative  
Taylor polynomial  
Integral  
Gradient  
Divergence  
Curl  
Laplacian  
Scalar potential  
Vector potential

**Prob. & Stat. ...**

Average  
Mean square  
Deviation  
Fit

**Graph ...**

2D rectangular  
2D polar  
2D parametric

Continued on the next page

**Solve ...**

Symbolically  
Numerically  
y iterations

**Transform in ...**

asic  
C  
FORTRAN  
LaTeX  
Pascal

**Write to ...**

LaTeX  
RTF

## Conclusion

The ME-DERIVE interface was used to create the package Solver 99.2. This package is a tutorial system for technical universities. It consists of the examples of problem solution. Using the package, the students can learn how to solve more than 120 typical problems. Here is the package Table of Contents.

## 1. Analytic geometry

- 1.1. The coordinates of a vector in a given basis
- 1.2. Collinear vectors
- 1.3. Angle formed by vectors
- 1.4. The area of a parallelogram
- 1.5. Coplanar vectors
- 1. . Volume and height of a tetrahedron
- 1. . Distance between point and plane
- 1.8. Equation of a plane with a given normal vector
- 1.9. Angle formed by planes
- 1.10. Canonical equation of a straight line
- 1.11. Intersection point of a straight line and a plane

- 1.12. Projection of a point on a plane or a straight line
- 1.13. Symmetry with respect to a plane or a straight line

## 2. Linear algebra

- 2.1. Notion of a linear space
- 2.2. Systems of linear equations
- 2.3. Linear operators
- 2.4. Matrix, range, rank, kernel, and defect of a linear operator
- 2.5. Manipulations with linear operators and their matrices
- 2. . Transformations of the vector coordinates
- 2. . Transformations of the operator matrices
- 2.8. Eigenvalues and eigenvectors

### 3. Limits

- 3.1. Notion of the sequence limits
- 3.2. Calculation of  $\lim_{n \rightarrow \infty} P_k(n)/Q_m(n)$
- 3.3. Calculation of  $\lim_{n \rightarrow \infty} f(n)/g(n)$
- 3.4. Calculation of  $\lim_{n \rightarrow \infty} u(n)^{v(n)}$
- 3.5. Notion of the function limits
- 3. . Continuity of a function
- 3. . Calculation of  $\lim_{x \rightarrow a} P_n(x)/Q_m(x)$
- 3.8. Calculation of  $\lim_{x \rightarrow 0} f(x)/g(x)$
- 3.9. Calculation of  $\lim_{x \rightarrow a} f(x)/g(x)$
- 3.10. Calculation of  $\lim_{x \rightarrow 0} u(x)^{v(x)}$
- 3.11. Calculation of  $\lim_{x \rightarrow a} u(x)^{v(x)}$
- 3.12. Calculation of  $\lim_{x \rightarrow a} F(u(x)v(x) + f(x))$

## 4. Differentiation

- 4.1. Notion of a derivative
- 4.2. Calculation of derivatives
- 4.3. Equations of tangent and normal to a curve
- 4.4. Approximate calculations using differentials
- 4.5. Using logarithmic derivatives
- 4. . Derivatives of parametric functions
- 4. . Equations of tangent and normal to a parametric curve
- 4.8. Higher order derivatives
- 4.9. The Leibnitz rule
- 4.10. Second derivatives of parametric functions

## 5. Investigating functions

- 5.1. Function investigation and graphical representation
- 5.2. Maximum and minimum values of a function
- 5.3. Using higher derivatives

## . Functions of several variables

- .1. Partial derivatives
- .2. Gradient
- .3. Derivative in a direction
- .4. Chain rule
- .5. Derivatives of implicit functions
  - . . Tangent and normal to a surface
  - . . Maxima and minima



## . Indefinite integral

- .1. Simple examples
- .2. Integration by parts
- .3. Integration of rational functions with simple real roots of denominators
- .4. Integration of rational functions with multiple real roots of denominators
- .5. Integration of rational functions with simple complex roots of denominators
- . . Integration of  $R(\sin x, \cos x)$
- . . Integration of  $\sin^{2m} x \cdot \cos^{2n} x$
- .8. Integration of  $R\left(x, \left(\frac{ax+b}{cx+d}\right)^{p_1/q_1}, \left(\frac{ax+b}{cx+d}\right)^{p_2/q_2}, \dots\right)$
- .9. Integration of  $R(x, (a^2 \pm x^2)^{1/2})$  and  $R(x, (x^2 - a^2)^{1/2})$
- .10. Integration of differential binomials

## 8. Definite integral

- 8.1. Simple examples
- 8.2. Integration by parts
- 8.3. Integration of  $R(\sin x, \cos x)$
- 8.4. Integration of  $\sin^{2m} x \cdot \cos^{2n} x$
- 8.5. Integration of  $R\left(x, \left(\frac{ax+b}{cx+d}\right)^{p_1/q_1}, \left(\frac{ax+b}{cx+d}\right)^{p_2/q_2}, \dots\right)$
- 8. . Integration of  $R(x, (a^2 \pm x^2)^{1/2})$  and  $R(x, (x^2 - a^2)^{1/2})$
- 8. . Calculating the areas
- 8.8. Calculating the lengths of  $y = f(x)$
- 8.9. Calculating the lengths of  $x = x(t), y = y(t)$
- 8.10. Calculating the lengths of  $\varrho = \varrho(\varphi)$
- 8.11. Calculating the volumes
- 8.12. Calculating the volumes of rotational-symmetric bodies

## 9. Line integrals

9.1. Integrals w.r.t. arc length

9.2. Integrals w.r.t. variables  $x, y, z$

## 10. Series

10.1. Notion of the series sum

10.2. Using term by term comparisons

10.3. Comparing the orders of magnitude

10.4. d'Alembert criterion

10.5. Cauchy 1st criterion

10. . Cauchy 2nd criterion

10. . Leibnitz criterion

10.8. Approximate calculation of the series sum

- 10.9. Convergence domain of a functional series
- 10.10. Convergence domain of a power series
- 10.11. Calculation of the series sum using integration
- 10.12. Calculation of the series sum using differentiation
- 10.13. Taylor series
- 10.14. Using series in approximate calculations

## 11. Ordinary differential equations

- 11.1. Notion of a solution
- 11.2. Equations with separable variables
- 11.3. Homogeneous equations
- 11.4. First-order linear equations
- 11.5. Bernoulli equation

- 11. . Equations with exact differentials
- 11. . Equations  $F(x, y^{(k)}, y^{(k+1)}) = 0$
- 11.8. Equations  $F(y, y', y'') = 0$
- 11.9. Linear equations with constant coefficients
- 11.10. Superposition of solutions
- 11.11. The Lagrange method

## 12. Multiple integrals

- 12.1. Changing the integration order
- 12.2. Double integral in Cartesian coordinates
- 12.3. Double integral in polar coordinates
- 12.4. Double integral in generalized polar coordinates
- 12.5. Calculating the volumes using double integrals

- 12. . Calculating the areas in Cartesian coordinates
- 12. . Calculating the areas in polar coordinates
- 12.8. Calculating the masses of plaques
- 12.9. Triple integral in Cartesian coordinates
- 12.10. Triple integral in cylindrical coordinates
- 12.11. Triple integral in spherical coordinates
- 12.12. Calculating the volumes using triple integrals
- 12.13. Calculating the masses

### 13. Surface integrals

- 13.1. Surface integrals
- 13.2. Integral over cylindrical surface
- 13.3. Integral over spherical surface

## 14. Vector analysis

14.1. Vector curves

14.2. Flux of a vector field

14.3. Flux of a vector field across a part of a cylinder

14.4. Flux of a vector field across a part of a sphere

14.5. Calculating fluxes using the Ostrogradski formula

14. . Work of a force

14. . Circulation of a vector field

14.8. Calculating circulations using the Stokes formula

The problem solutions were obtained as texts in the DERIVE language and converted in the LaTeX for publishing in a book. The final LaTeX document was converted in the RTF file. Thus, the document

became readable by Word. The solutions of all problems were verified using the Word-DERIVE interface. Thus, the ME-DERIVE and the Word-DERIVE interfaces were tested on about 120 above-mentioned problems. The tests showed that the interfaces are effective and easy to use. The Word-DERIVE interface is included in the package Solver 99.2. Therefore, the users of the package can communicate with DERIVE during the problem solution. They can copy the examples of problem solutions, modify them, and give to teachers as the home exercises.

oth interfaces are distributed as the stand-alone applications. I can send them by E-mail. Soon they will be on servers. The interfaces are free until the February 2000. Any suggestion, bug report, and criticism is highly appreciated.