

INTEROPERATION BETWEEN SOFTWARE TOOLS FOR ELECTROMAGNETIC PROBLEMS INVOLVING MATERIALS WITH HYSTERESIS

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Abstract. *GiD is extended for being used together with an electromagnetic CAD tool developed in-house, dedicated for the experimental and numerical characterization of materials with hysteresis. The new GiD functionality allows the definition of an electromagnetic field problem including magnetic materials with hysteresis.*

1 INTRODUCTION

The paper presents the interoperation between several CAD software tools, to completely solve the electromagnetic field problems involving materials with hysteresis. GiD has its important role in this development cycle, not only as a standard CAD pre- and post-processor. Supplementary, the preprocessor imports the material data from HystMagⁱ – an in-house developed software for advanced characterization of magnetic materials. The material behavior is described by analytic, differential or statistic models of hysteresis, whose parameters are identified by HystMag from the experimental data supplied by equipment like Vibrating Sample Magnetometer or Hysteresisgraph. The GiD preprocessor creates the .MAT file with magnetic materials using Tcl/Tk scripting language and can export the problem model to a dedicated electromagnetic solver (e.g. for the quasi-stationary magnetic field computation, based on the FEM numerical methodⁱⁱ).

2 MAGNETIC MATERIAL LIBRARY

This work is based on the magnetic material library created with HystMagⁱ, a software system that integrates the experimental methods with the numerical modeling of magnetic materials. It is dedicated for research and a high level education stage and is composed of the following functions: creating a collection of materials and hysteresis modelsⁱⁱⁱ characterizing the materials by associating models and identifying their parameters, testing the material modeling for different geometrical configurations present in the devices.

A hysteresis model has information regarding its input and output magnitudes, the type of its parameters (constant or functions) and integrates executables implemented in any language, on a Windows platform. The selection of a material-model pair allows the user to run the identification procedure corresponding to the model (e.g. Preisach) with the inputs taken from the experimental data characterising the material. The description of the model is saved into a configuration text file with “cfg” extension and, for a selected material, the model identification program creates an output file in the same subdirectory, with the name “output.txt”.

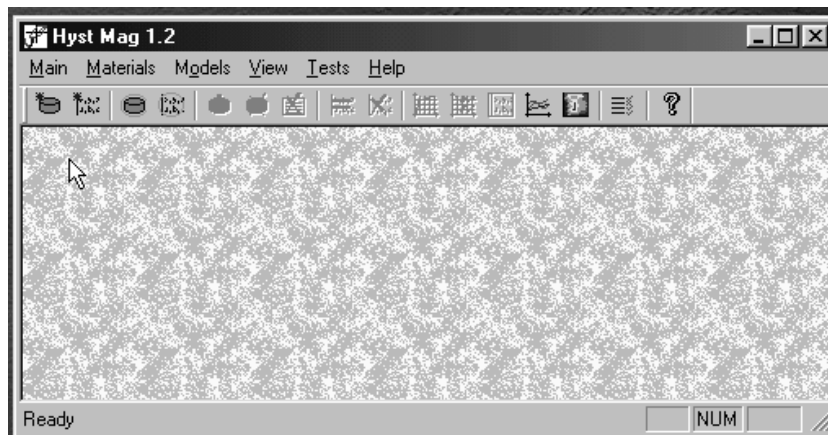


Figure 1: HystMag main menu

3 IMPORTING MAGNETIC MATERIALS TO GiD

HystMag allows the description of magnetic materials and the creation of an information base, which may be continuously enriched. In the following presentation, a material actually means a material modeled by an associated model, whose parameters have been identified. For example, the material named AlnicoPreisach is an Alnico permanent magnet, modeled by a classical Preisach model. Thus, recreating this kind of materials in GiD is not convenient and a new functionality was introduced to import materials from HystMag. This is made with a .tcl file, which should be included in electromagnetic problem types. It generates a new submenu File->Import->HystMag, which give the user the possibility to import any number of modeled materials, reading the information from the HystMag files (MaterialName.cfg and output.txt) and writing them in the proper format of a .MAT file in GiD.

The configuration file in HystMag has the structure: Id[TAB]Name[CR][LF], where

- Id – is an ASCII character that may take the values: i – input parameter, o – output parameter, c – constant parameter, f – 2D function-parameter, g – 3D function- parameter
- Name – is a string that defines the parameter name
- [TAB], [CR], [LF] – define the TAB, Carriage Return and Line Feed characters

The values of the model parameters are given in the same subdirectory, in the output.txt file, with the format: ParameterName[TAB]value[CR][LF]. If a parameter has more values (e.g. a function-type parameter) the line is simply repeated for each value set. GiD allows the visualization of the imported materials, like in Fig. 2 for a NdFeB magnet, modeled by a Preisach model whose numerical statistical function is identified by a decomposition procedure. A part of the import procedure in Tcl/Tk is presented in Fig. 3.

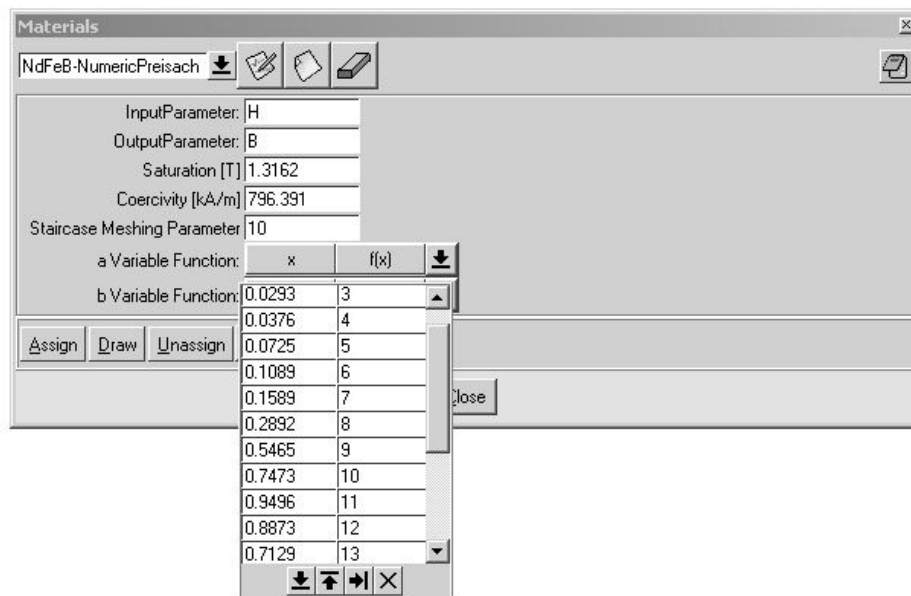


Figure 2: View of a NdFeB material, modeled with numerical Preisach model

```

proc ImportHyst_MAG {} { ...
    set FileConfigName [tk_getOpenFile -title "Select Material File (.cfg)"]
    while { ![eof $fHystConfig] } {
        gets $fHystConfig line
        set c [string index $line 0]
        set s [string range $line 2 end]
        if {[string equal $c g]} {
            set notexist3D 0
            puts -nonewline $fGIDMaterial "QUESTION: "
            puts -nonewline $fGIDMaterial $s
            puts $fGIDMaterial ":(x,y,f(x,y))"
            gets $fHystOutput line
            scan $line %s%s s1 value
            set s2 $s1
            set StrValues " "
            set numberOfValues 0
            while {[string equal $s2 $s1]} {
                set StrValues [concat $StrValues $value ]
                incr numberOfValues
                if { [eof $fHystOutput] } break
                gets $fHystOutput line
                scan $line %s%s s2 value }
            set StrValues [concat "VALUE: #N#" $numberOfValues $StrValues]
            puts $fGIDMaterial $StrValues }}

```

Figure 3: A sample of the Tcl/Tk code for importing hysteretic materials

4 CONCLUSIONS

The use of Tcl/Tk language for coupling GiD preprocessor with a tool dedicated to the characterization of magnetic materials by experimental data and numerical models allows an easy extension of the approached problem types. So, the .MAT file, which contains materials with hysteresis, may be used for passing the data to a solver dedicated to an accurate analysis of electromagnetic problems for devices containing magnetic materials with hysteresis.

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