High Energy

High Intensity

Hadron Beams

Database Design for Superconducting Magnets

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Abstract

The project concerns the design and implementation of a web interface for the superconducting materials and, in particular, superconducting magnets. The huge amount of literature and data related to superconductivity could be dispersive for a scientist who needs information for superconductor technology. This project is the starting point for a new database which collects the most important features and characteristics of superconducting materials, cables, strands and magnets. In a first stage of the project, it is important to create a flexible template for the most general data description. With this template, it is simpler to create a database with no limitation with respect to the developments in the field of superconductors. Based on the design of a template, the database implementation follows in Oracle on the standard CERN platform. The last stage concerns the design and implementation of a clear and simple web interface in order to access and modify the data on the database.

1. Collection of Main Parameters

This is the starting point of the project. Due to a vast amount of data to be implemented to the database, it is crucial to collect and systemise parameters by which the data can be arrayed. There are two main categories, the Materials and Projects, into which the whole

database structure is divided. The Projects are subdivided into three subcategories, cables, strands and magnets, as shown in Figure 1.

<Figure 1.Structure of the Database>
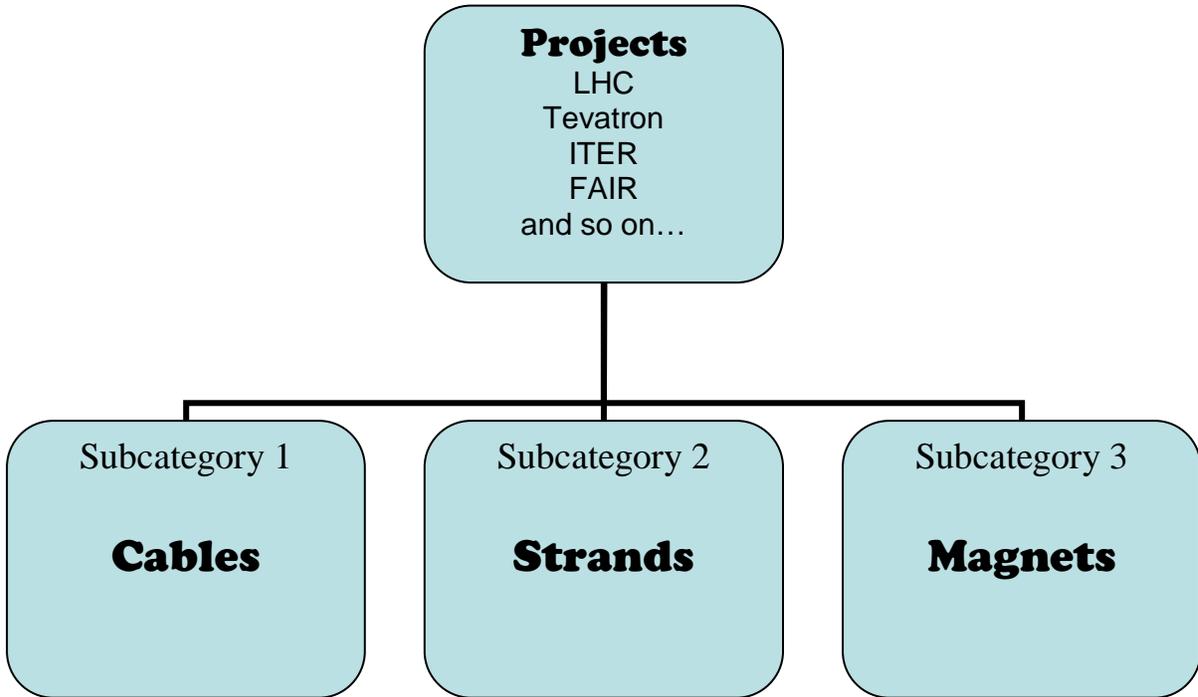
The collection of main parameters by which each category and subcategory can be characterised is the starting point of this project. Different parameters are collected under different headings. As far as the parameter collection is concerned, the substructure of the Projects is hidden and an independent parameter collection for each of materials, projects, cables, strands and magnets has been carried out and those five are regarded as five main categories. A few exemplary parameters for different categories and subcategories are shown in Table 2.

<Table 2.Exemplary parameters for different categories>

Category / Subcategory	Main Parameters
Materials	• General properties, e.g. name of material, manufacturer and so on • Critical current density • Critical magnetic field strength • Critical temperature • Ductility
Projects	• Name of project • Laboratory

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	• Location & country • Reference • Contact details for people involved
Cables	• Cost per unit mass • Number of strands • Cable dimension • Critical current • Expected quenching characteristics and temperature margin
Strands	• Coating Type • Critical current • Copper to superconductor ratio • Magnetisation • Temperature margin
Magnets	• Magnetic field strength • Required current • Quenching behaviour • Operating region of superconductivity

2. Survey Website

There are a number of projects which involve superconductivity science. Some notable examples of such projects are LHC at CERN, Tevatron at FermiLab in the US, FAIR at GSI in Germany and KEKB and ILC at KEK in Japan, and so forth. In order to initially arrange the parameters and reflect the professional opinions on these from people who are involved in such projects, a survey webpage has been created. The following is the URL address for it:

http://sdb.web.cern.ch/sdb/

It began with the main parameters which had been previously collected. The website is facilitated such that people can view the parameters to be systemised in the database and they can add comments or suggest potential improvements.

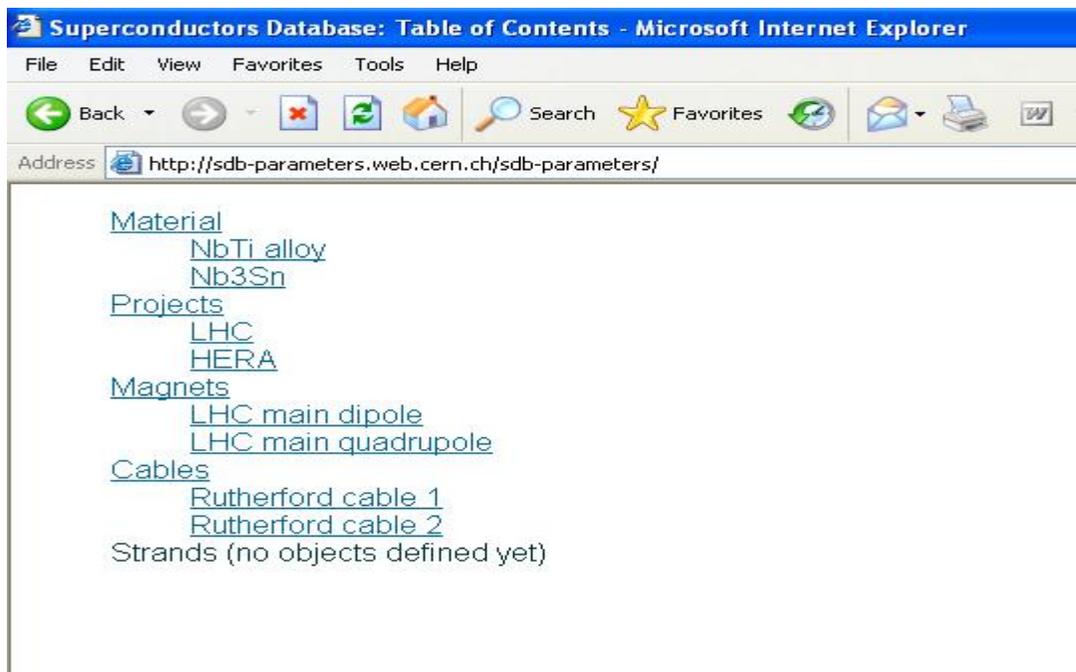It is necessary to understand HTML and Perl, a scripting language, to some extent, to manage this survey website.

3. Database Structure and Web Interface Construction

3.1. Overview of Database and Web Structures

The management of the database is done using Golden32 of the Benthic software. A web interface where the tables can be displayed is created using Java in such a way that any change made in the database is immediately reflected in the resulting tables – this is also how one can check the structure of the database as he/she constructs it. The URL address for this website is the following:

http://sdb-parameters.web.cern.ch/sdb-parameters/

My task was to identify what can be achieved using the software available for database design and to show how such a table can be designed, modified and managed. The followings are the brief introduction to the database and guideline instructions on how one can modify the database for future developments. As in parameter collections, although one should conceptually have a substructure for Projects, the database. A temporary view of the overall structure is shown in Figure3.

<Figure 3.A brief view of the database via the web interface>

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<Figure 4.The Material table>

Figure 4 shows the table created in the Material section. Different materials can be listed in columns, and the rows are used for various parameters under different headings such as general properties and mechanical properties and so on. In both directions of columns and rows, the tables can be extended and this flexibility is a great feature of Golden32 for further developments and modifications. This feature identically applies to the other main categories, e.g. Projects, Magnets, Cables and Strands.

In fact, the tables are constructed on the equal footing for each of the main categories. In other words, all the features of the tables can be assumed to be identical except for the entries of the tables. Hence, in the next sub-section where some explanations for how to modify the tables are given, it is sufficient to discuss the table for the Material. A precise analogy can be followed for the other main categories.

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3.2. Creation and Modification of tables

Using Golden32 of Benthic software, modifications are partial steps embedded in creations. Therefore, once one understands how to create a table, how to modify it should not matter. For this reason, the following content concentrates on creation of tables.

In order to create a table, some essential items listed below must be defined.
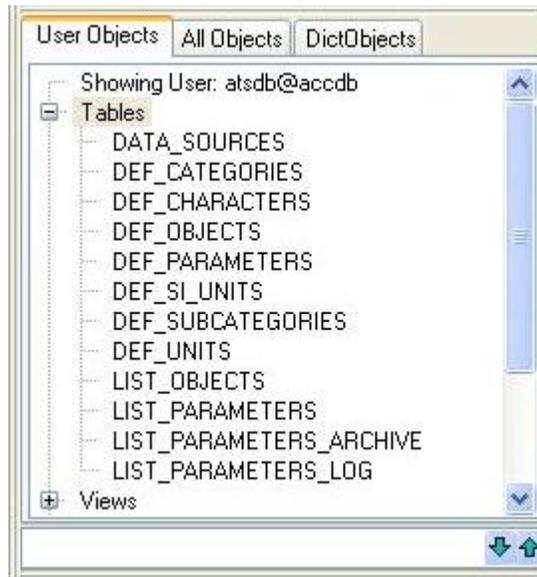
1. Categories
2. Sub-categories
3. Parameters
4. Objects

This can be viewed in Golden32 by [View → SQL Builder], [F9]-key or equivalently the key red-circled in Figure 5.
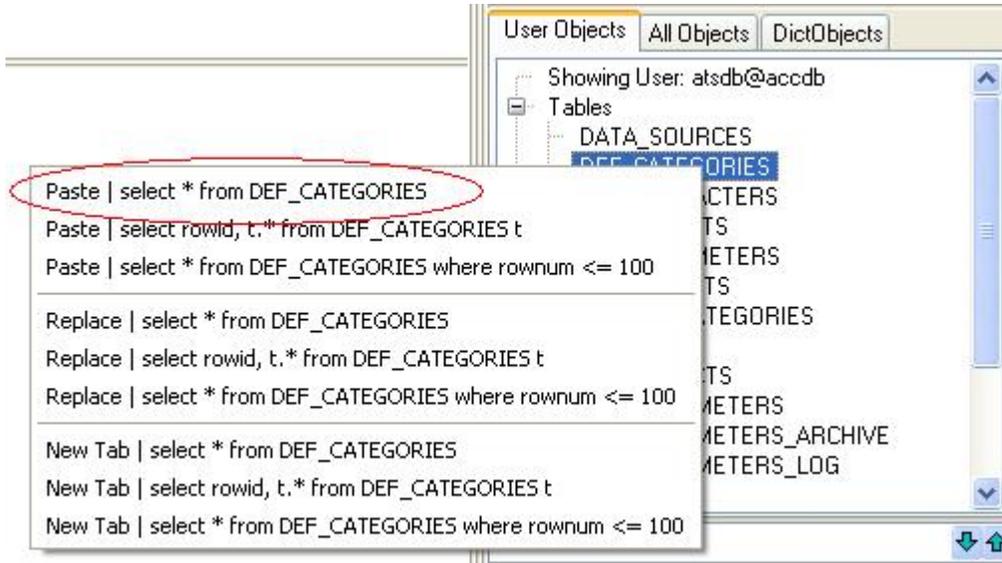

<Figure 5.SQL Builder key in Golden32>

The outcome is shown below in Figure 6.

<Figure 6.A list of items to be defined shown under User objects>

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3.2.1. Categories

Right-click DEF_CATEGORIES and choose [select * from DEF_CATEGORIES].

<Figure 7.Define categories>

Then the following will be shown in the Query window.

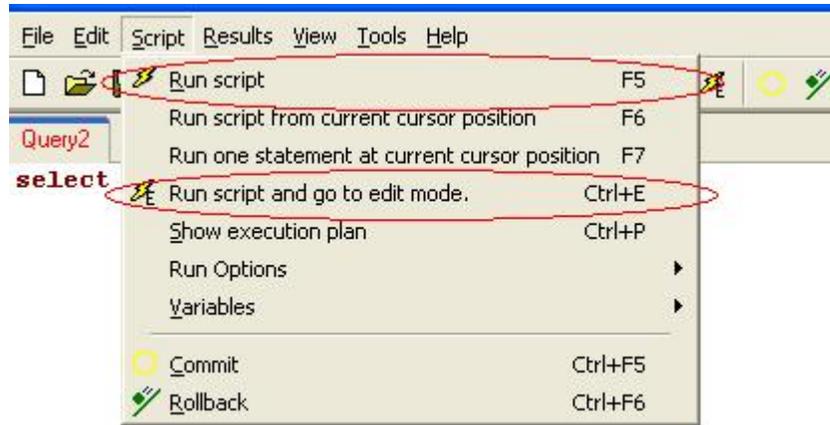<Figure 8.Query Window appearance>

Now select [Script → Run script (F5)] to execute the command or [Script → Run script and go to edit mode (Ctrl+E)]. Equivalent keys, circled in the figure below, may be chosen as shown below.

<Figure 9.Run and edit script keys>

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<Figure 10.Run and edit script menu>

The difference between [Run script] and [Run and Edit script] is literal, in other words, the former allows only for running whereas the latter allows for both running and editing. This is seen in the following two figures.

#	OBJECT_TYPE	CATEGORY	ORDER_NU	TITLE	INSERT_DATE
1	project	general	1	General information	09/15/2006 17:42:11
2	magnet	general	1	General properties	09/15/2006 17:42:53
3	magnet	performance	2	Performance	09/15/2006 17:43:10
4	cable	general	1	General information	09/15/2006 17:48:00
5	cable	properties	2	Properties	09/15/2006 17:48:22
6	cable	add	3	Additional factors	09/15/2006 17:48:31
7	material	general	1	General Properties	09/22/2006 12:04:10
8	material	mechanical	3	Mechanical Properties	09/22/2006 12:02:43
9	material	physical	4	Physical Properties	09/22/2006 12:03:04
10	material	main	2	Main Parameters	09/22/2006 12:04:07
11	material	chemical	5	Chemical Properties	09/22/2006 12:09:23
12	material	electro	6	Electromagnetic Properties	09/22/2006 15:59:20

<Figure 11.Result of [Run select * from DEF_CATEGORIES]>

Editing: TABLE ATSDB.DEF_CATEGORIES

#	OBJECT_TYPE	CATEGORY	ORDER_NU	TITLE	INSERT_DATE
1	project	general	1	General information	09/15/2006 17:42:11
2	magnet	general	1	General properties	09/15/2006 17:42:53
3	magnet	performance	2	Performance	09/15/2006 17:43:10
4	cable	general	1	General information	09/15/2006 17:48:00
5	cable	properties	2	Properties	09/15/2006 17:48:22
6	cable	add	3	Additional factors	09/15/2006 17:48:31
7	material	general	1	General Properties	09/22/2006 12:04:10
8	material	mechanical	3	Mechanical Properties	09/22/2006 12:02:43
9	material	physical	4	Physical Properties	09/22/2006 12:03:04
10	material	main	2	Main Parameters	09/22/2006 12:04:07
11	material	chemical	5	Chemical Properties	09/22/2006 12:09:23
12	material	electro	6	Electromagnetic Properties	09/22/2006 15:59:20

<Figure 12.Result of [Run and Edit select * from DEF_CATEGORIES]>

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The latter mode, shown in Figure 11, is the one needed for creations and modifications as it allows for editing.

Warning. Categories here are different from the main categories discussed above. The main categories refer to Material, Projects, Cables, Strands and Magnets. On the other hand, categories defined here refer to main properties classifications of those main categories. For example, general properties, mechanical properties and physical properties and so on belong to categories.

There are five columns and a brief explanation for each of them is given below.

    I.   Object_type – Specify the main categories.

   II.   Categories – This is where you type in the category that you wish to define in this session.

   III.   Order_nu – You are allowed to order the categories according to which they are represented in the resulting table(s).

   IV.   Title – The title typed in here will be shown in the resulting table(s).

   V.   Insert_date – This shows the date of being last defined or modified.

As far as what we have in Figure 11 is concerned, there are five categories under Material, one category under Projects, three categories under Cables and two categories under Magnets. Figure 4 shows how the categories defined under Material in this way are shown in the resulting table.

3.2.2. Subcategories and Parameters

The next items to be defined are subcategories and parameters. They have identical interface structure, hence the instructions introduced in 3.2.1. can be repeated for these. The only difference is to change from CATEGORIES to either SUBCATEGORIES or PARAMETERS.

3.2.3. Objects

This sub-section is separately made for Objects because it has one different feature, although the procedures are again identical to those for the categories. Categories, subcategories and parameters were defined and modified by [DEF_*], where * can be substituted by CATEGORIES, SUBCATEGORIES and PARAMETERS, respectively. On the other hand, the objects for each category are defined by [Paste | select * from LIST_OBJECTS]. This can be chosen by right-clicking LIST_OBJECTS in the list of User_Objects.

Conclusions

A number of parameters has been collected as a guideline. A further collection may be required for a higher accuracy, a better reliability and further developments and improvements. In addition to this, a further systemisation of parameters is necessary as this is the starting point of the database and its structure formation.

What are plausible functions in the database using Golden32 of Benthic software are identified. Consequently, some basic database and web interface structures are formed onto which further extensions are possible. It is a great advantage of Golden32 to create and modify the tables in the similar manner to how they are presented as the final outcomes.

Once the final version of the database and tables are created in the database, reliable data are to be collected and implemented. Some managerial points of view on how to make reliable data reliable are to be discussed.

A user friendly web interface would play an important role in attracting many users. Further discussions are needed for the implementation of user-friendly search engine. Easiness to use and clear layout should also be regarded as important issues. A web function to receive feedbacks from users could also be an efficient way to improve the database.

Acknowledgements

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