

# DATABASE DESIGN AT SYNTHESIS OF ELECTROMECHANICAL MODULES

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**Abstract:** In accordance with the global concepts for machine design based on the modular principle, the main modules, which are the same for the different types of working machines, are the electromechanical modules, also called geared-motor modules. Because of the multivariance of the task for their design, a database containing the technical parameters and characteristics of the main constructive units needs to be build.

**Key words:** ELECTROMECHANICAL MODULES, DATABASE, GEARED-MOTOR, ELECTRIC MOTOR, GEAR REDUCER

## 1. Introduction

The electromechanical modules (EMM) represent the constructive unification of the electrical and the mechanical part of the drives of the different types of working machines. In the majority of cases, the combination is between an electrical motor and a gear reducer, known also in the literature and the practice under the name geared-motor, respectively geared-motor module. In some case, the connection between the electric motor and the gear reducer is realized by means of a clutch. Depending on the selection of electric motor, gear reducer and clutch, at the same values for the input data, the realization of multiple variants of EMM is possible [Genova, etc. 2011]. Their unification in a single database facilitates the process for selecting the suitable for a concrete application EMM, as well as gives an opportunity for creating a software for optimal selection.

## 2. Formulating the problem

In terms of the structure, the database (DB) must contain information about the main constructive units of the EMM – electric motors, gear reducers and clutches. At certain point, this can turn out to be large amount of data, for the unification of which in a single DB, the most simple and functional structure that is easy to update and maintain needs to be built. Furthermore, the interface of the database needs to be user-friendly and to ensure fast and easy access to the information. This can be achieved by designing a relational DB, which is the most commonly used type [Hernandez 2003]. This is due to the fact that in comparison with the other models – hierarchical, network and object-orientated, at the relational DB structuring and updating the information, as well as building the relations between the separate tables is performed very easy. The nature of a relational DB is the correct building of the relations between the different tables that compose it [Garcia-Molina et al., 2009].

Fig. 1 shows an exemplary block-scheme of the general view of the database structure. The rectangles indicate the main tables that built the database – electric motors, clutches, gear reducers and the possible combinations between them. These tables contain technical parameters of the components:

- table electric motors – type of motor (for AC or DC current, asynchronous, synchronous, etc.), nominal power, nominal and synchronous speed of the motor shaft, nominal and maximal torque, nominal current, efficiency, IE efficiency class, weight, manufacturer;
- table gear reducers – type of gear reducer (cylindrical, bevel, worm, etc.), number of stages, mounting (horizontal or vertical), ration, efficiency;
- table electromechanical modules – the possible combinations between electric motors and gear reducers and their respective technical and geometrical parameters.

The blue rhomb indicates between which tables a relationship needs to be built. The block-scheme given on fig. 1 is exemplar. The information, which is contained in the tables, could be supplemented or removed, as well as the tables themselves.

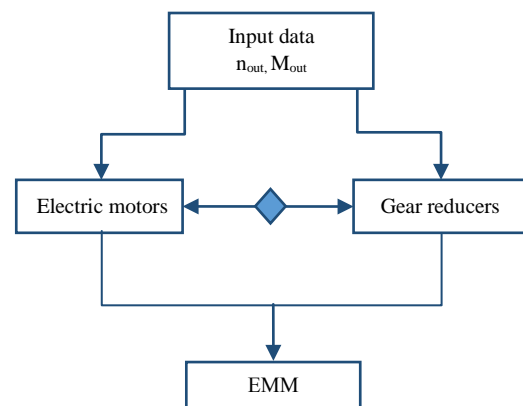


Fig. 1 Block-scheme of exemplary structure of the DB

## 3. Designing the database

In order to build a database, the so-called database management systems (DBMS) are used. These are the programs (software) by which a DB is designed and which ensures fast access to them and gives the opportunity for their updating and maintenance. One of the most commonly used DBMS are Oracle, MS Access, Paradox, FoxPro, Sybase, dBase, etc.

We have developed two versions of the database, using the software MS Access 2013. These versions differ from each other concerning their structure.

### Version 1:

This version is the simplest one. It consists of only one table (shown in Table 1). The table contains information about all possible combinations of the structural units, obtained based on the input data. In order to simplify as much as possible the DB, the geometrical parameters of the obtained variants of EMM and some of the technical data about the electric motors and the gear reducers were exported in a separate file, for every concrete variant. The access to these files is done by clicking on the according hyperlink in the Gear\_Mot\_ID field.

For the convenience of the user, a search form has been created. Upon entering values for the input data and clicking on the functional button "Search", the search results are outputted. This is done by the means of a so-called query, in which search criteria based on the entered values for the input data are assigned. Fig. 2 shows the general view of this query.

### Version 2:

This version of the DB also consists of a table with the technical parameters of the possible combinations of EMM – identical in its

structure with the table in the first version, but in this case, there are also two more tables.

One of the tables contains data about electric motors of concrete companies and the other one contains data about the different types of gear reducers. In all three tables, there is one field, which indicates the identification number of every single record (row). This identifier is the so-called primary key and is unique for every record. The relations between the tables are built with the help of these primary keys. Another auxiliary table is built, which connects the three main tables, because it is not possible to create more than one relation from a single primary key.

This version of the DB also have a search form, which is identical with the form from the other version. The difference here is in the query, at which not only the search criteria are defined, but also the relations between the tables. Thereby, upon entering values for the input data in the search form and clicking on the functional button "Search", the results show preliminary defined fields from all tables. Fig. 3 shows the general view of the query for version 2 of the DB.

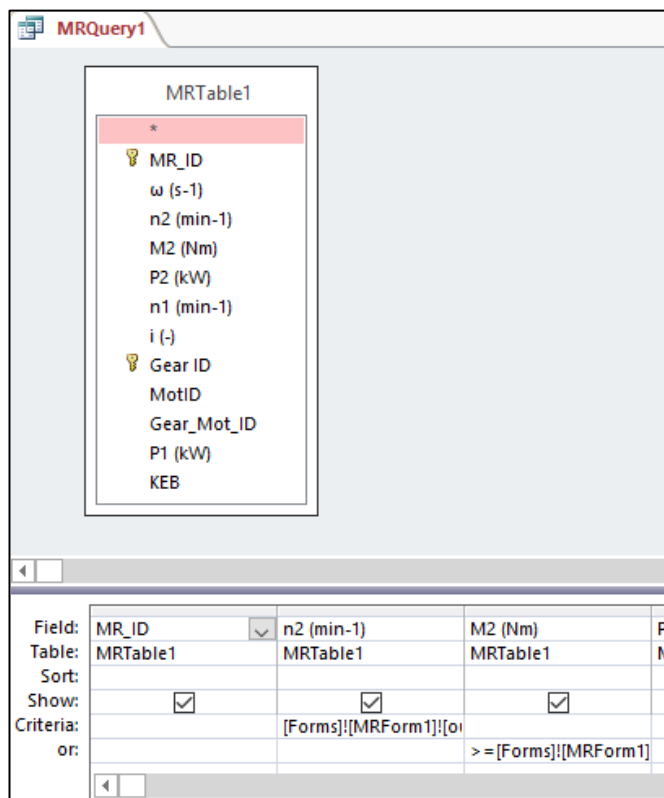


Fig. 2 Query - version 1

#### 4. Numerical example

EMM design at the following input data:  $n_{out} = 65 \text{ min}^{-1}$ ;  $M_{out} = 95 \text{ Nm}$ .

Depending on the type of the electric motor and the gear reducer, different variants of EMM are obtained. The database – electric motors contains asynchronous squirrel cage motors with different number of pole pair, i.e. different values for the speed of the input shaft  $n_{in}$ , namely: 2-pole electric motor ( $n_{in} = 3000 \text{ min}^{-1}$ ), 4-pole electric motor ( $n_{in} = 1500 \text{ min}^{-1}$ ), 6-pole electric motor ( $n_{in} = 1000 \text{ min}^{-1}$ ) and 8-pole electric motor ( $n_{in} = 750 \text{ min}^{-1}$ ).

The input power is calculated ( $P_{in} = 0,67 \text{ kW}$ ), based on the output power ( $P_{out} = 0,65 \text{ kW}$ ) and previously accepted indicative value for the efficiency. For the concrete case, an electric motor with nominal power  $P_{nom.} = 0,75 \text{ kW}$  has been selected that guarantees the realization of the input data. The ratios are calculated, based on which are defined the gear reducers by which these variants can be obtained – cylindrical, bevel, cylindrical-bevel, worm and worm-cylindrical. 51 different variants of EMM are obtained. Fig. 4 shows the results of the search in the search form of version 1 of the DB, and fig. 5 shows the results at version 3 of the DB.

#### 5. Conclusion

Version 2 of the DB is more complex, but updating and maintaining such structure is easier. Also, the volume of the DB is smaller, because at his version there are no external files.

At version 1, for every EMM that is added in the DB, a new file with technical parameters of the electric motor and gear unit, that comprise it, needs to be created, which additionally compounds the DB. On the other hand, at version 1 the information is better illustrated in the search form, because the user can open only the file with technical data of this variant of EMM that satisfies its requirements.

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#### 6. Literature

Genova P., Dahterova D., Tsoneva M., Theory of machine design. Sofia, 2011.

Hernandez M. Database Design for Mere Mortals™: A Hands-On Guide to Relational Database Design, Second Edition. USA, 2003.

Hector Garcia-Molina H., Ullman J., Widom J. DATABASE SYSTEMS The Complete Book, Second Edition. USA, 2009.

Table 1: General view of the table in the first version of the DB

MR_ID	$\omega$	$n_{out}$	$M_{out}$	$P_{out}$	$P_{in}$	$n_{in}$	$i$	Gear_Mot_ID
MRi i=1, 2, .. n	const calc	const	const	const calc	const calc	var	var calc	var hyperlink

Description: const-constant values; var-variable value; calc-calculated values; hyperlink-link to external file; MR\_ID – identification number of all of the obtained variants;  $\omega$  – input angular speed, it is calculated, [s<sup>-1</sup>];  $n_{out}$  – output speed, [min-1];  $M_{out}$  – output torque, [Nm];  $P_{out}$  – output power, it is calculated, [kW];  $P_{in}$  – input power, it is calculated, [kW];  $n_{in}$  – input speed, [min-1];  $i$  – ratio, it is calculated, [-]; Gear\_Mot\_ID – hyperlink type of field

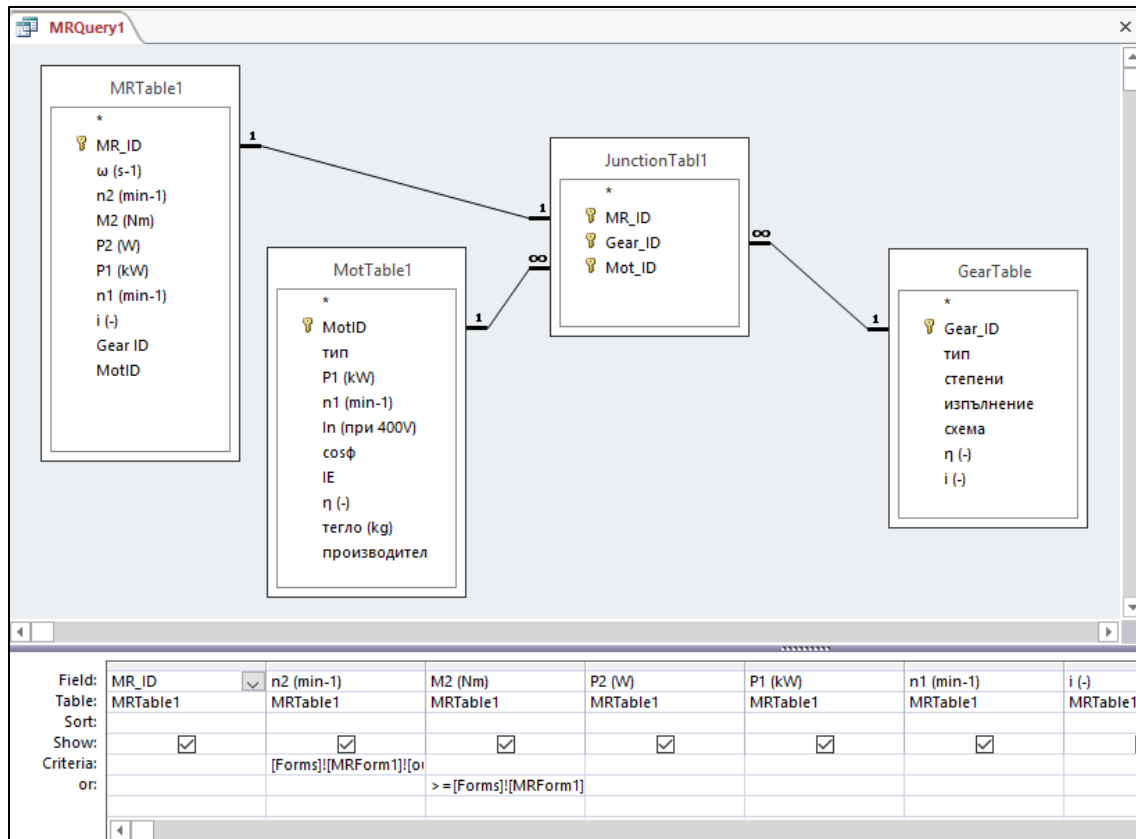


Fig. 3 Query – version 2

### Търсене

изходящи обороти n2 (min-1):       изходящ въртящ момент M2 (Nm):

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**Резултати:**

MR_ID	n2 (min-1)	M2 (Nm)	P2 (kW)	P1 (kW)	n1 (min-1)	i (-)	Gear_Mot_ID
MR0001	65	95	0.65	0.67	3000	46.15	<a href="#">G5 M3-2</a>
MR0002	65	95	0.65	0.67	3000	46.15	
MR0003	65	95	0.65	0.67	3000	46.15	
MR0004	65	95	0.65	0.67	3000	46.15	
MR0005	65	95	0.65	0.67	3000	46.15	
MR0006	65	95	0.65	0.67	3000	46.15	
MR0007	65	95	0.65	0.67	3000	46.15	
MR0008	65	95	0.65	0.67	3000	46.15	
MR0009	65	95	0.65	0.67	3000	46.15	
MR0010	65	95	0.65	0.67	1500	22.08	<a href="#">G2 M6-4</a>

Record: 14 | 1 of 51 | No Filter | Search

Fig. 4 Results from the search (version 1 of the DB)

MRForm

Търсене

изходящи обороти n2 (min-1):

изходящ въртящ момент M2 (Nm):

Търси

Изчисти

Обнови

Затвори

Резултати:

MR_ID	n2 (min-1)	M2 (Nm)	P2 (W)	P1 (kW)	n1 (min-1)	i (-)	Gear_ID	тип	степен
MR0001	65	95	0.65	0.67	3000	46.15	G5	цилиндричен	тристъпален
MR0002	65	95	0.65	0.67	3000	46.15	G6	цилиндричен	тристъпален
MR0003	65	95	0.65	0.67	3000	46.15	G7	цилиндричен	тристъпален
MR0004	65	95	0.65	0.67	3000	46.15	S1	червячен	едностъпален
MR0005	65	95	0.65	0.67	3000	46.15	S2	червячен	едностъпален
MR0006	65	95	0.65	0.67	3000	46.15	S3	червячен	едностъпален
MR0007	65	95	0.65	0.67	3000	46.15	S4	червячен	двустъпален
MR0008	65	95	0.65	0.67	3000	46.15	S5	червячно-цилиндричен	двустъпален
MR0009	65	95	0.65	0.67	3000	46.15	S6	цилиндрично-червячен	двустъпален
MR0010	65	95	0.65	0.67	1500	23.08	G2	цилиндричен	двустъпален
MR0011	65	95	0.65	0.67	1500	23.08	G3	цилиндричен	двустъпален
MR0012	65	95	0.65	0.67	1500	23.08	G4	цилиндричен	двустъпален
MR0013	65	95	0.65	0.67	1500	23.08	G5	цилиндричен	тристъпален
MR0014	65	95	0.65	0.67	1500	23.08	G6	цилиндричен	тристъпален
MR0015	65	95	0.65	0.67	1500	23.08	G7	цилиндричен	тристъпален
MR0016	65	95	0.65	0.67	1500	23.08	K2	конусно-цилиндричен	двустъпален

Fig. 5 Results from the search (version 2 of the DB)