

Bodybuilding Exercises Databases Development

Laurentiu CIOVICĂ

Academy of Economic Studies, Bucharest, Romania

ciovica_laurentiu@yahoo.com

Abstract: *In this article we analyze the necessity to design and build reliable databases for storing information about the necessary exercises in bodybuilding programs construction. We define the database structures for exercises, programs, equipments and muscle groups. We also analyze the level of redundancy necessary for a fair and flexible use of information by a variety of sportsman. Each sportsman has allocated resources to record its own evolution and to transfer certain information to these databases in order to complete and improve existing data sets with new experiences and results, highlighting the openness of the application in the way on how the information is added into database. .*

Keywords: *databases, exercises, programs, redundancy, analysis, design.*

1. Databases in bodybuilding

Bodybuilding is an extremely complex area and the transferred information refers to:

- The physical characteristics of sportsman obtain through measurements, photo shooting and / or competitions evolutions
- Training programs of sportsman individualized according to age, level of training, experience and defined objectives
- The actual workouts performed by sportsman and the recorded progress obtained through records and measurements
- The equipment with which the exercises are executed by sportsman and the used body weight lifting in order to realize the effort level which maximize both the muscles level and their definition level
- The coach's activity given by their defined programs, by the way on how they watch the sportsman activity and by their capacity to develop new workout systems. As well, for each coach the successes given by their trained sportsman are recorded.
- Organized competitions defined through their deployment scheduler, participant's selection criteria's, assessment rules, participants, peers teams, effective assessments and established hierarchies
- Diets specific to each sportsman type, taking in account the workouts and the established objectives.
- Estimation models for each category of sportsman behavior, the assessing resource needs, the assessing of sportsman performance and making corrections within the workouts structures caused by differences between planned levels of performance and the effective levels of performance achieved by each sportsman.
- Existing training rooms – specifying the GPS coordinates, endowment, the quality of services and especially by presenting the results of sportsman and coaches who have succeeded while.
- The specialized papers appeared in the field, magazines, books, memoirs, magazines, websites, videos, DVDs, photo albums, encyclopedias.

All this, must be the objective of a unitary treatment in the sense of creating a databases system which, similar to the meteorology system, records the evolutions of all aspects and creates huge and complex data storages.

After these complex data storages are well defined the system can be used in data analysis and in making accurate predictions about the sportsman evolution on short, medium and long term, only if data regarding the sportsman startup and intermediary evolution is well and complete defined.

It is well known that in meteorology based on accurate and complete data sets are build model sets used today in whether prediction and analysis.

In the same way we must also proceed in bodybuilding field. Huge data collections about sportsman, coaches, programs, workouts, diets, competitions, assessments systems, equipments, gyms must be created and defined in forms of:

- complete tables in which the data is gather using the same techniques and procedures
- images obtained in the same conditions for each sportsman
- 3D scanning measurements obtained in resting or concentrating
- vocabulary validated texts descriptions in which the quality levels obtained by sportsman are well defined and precisely mapped in ratings.

2. Open systems

Open systems are characterized through:

- The capacity of accepting new components of the same type with some existing components, in the view of extending the exposure area.
- The creation of new connections between the existing components to reflect real facts from the outdoor world in the system of which part is it
- Taking over new components, different from the existing one which has the role to bring on new features, so that the system in his whole capacity can create a new stage of development. In this way it satisfies the requests better, working towards the success of the objective for which it was created, in best conditions.
- The systematization of existing elements creating arrays of compact components, so that it can implements more efficient procedures destined to solution the problems
- Smoothing the flows, procedures, messages in the view of simplifying and raising the degree of satisfaction of the interactive users' high requests.

In the case of bodybuilding database system, the open state manifests though:

- Possibility that every sportsman can insert data of his/hers characteristics, about the practice schedule, about the way his/hers performances evolves, about diet, about the way it works.
- A sportsman creates a personal session of work, after existing models in the application he interacts with
- What the sportsman inserts with regularity is for his own experience bubble
- If there is a large number of sportsman, from them are selected only those that respect the requests of adding data in the system and they follow up data about their own experiences which are then taken by the open system of database. The only important criterion here is the quality of the given data.

3. Conceptual data modeling

Conceptual modeling has been primarily based on different dialects of the entity relationship (ER) model. The ER model has reached maturity such that it can be used for modeling of very complex applications. The basic constructs of the model (entity type, relationship type) are defined on the basis of set semantics, which can be understood intuitively by designers and users. [2]

In [3] the database conceptualization aims in a representation of the logical and physical structure of an information system in a given database management system (or for a database paradigm), so that it contains all the information required by the user and required for the efficient behavior of the whole information system for all users. Furthermore, conceptualisation may target to specify the database application processes and the user interaction.

Being a very important and powerful step in relational database design [2] the conceptual modeling overcomes several restrictions of the relational model [2]:

- structural optimization and behavioral optimization can be treated consistently during conceptual modeling if a powerful proof method is used during optimization;
- The same application can be modeled by different models. These models can be equivalent;
- conceptual modeling should integrate modeling of structures and behavior at the same time.

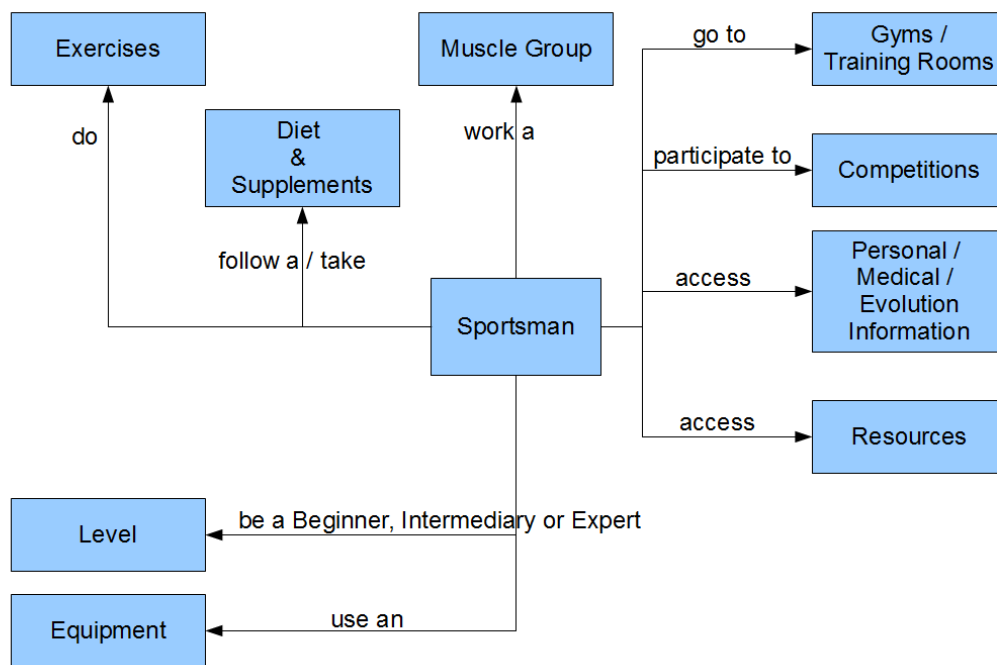


Fig. 1. Conceptualization

In Figure 1 we present a conceptualization approach for the bodybuilding database, which is a more like a short overview of a complex and distributed system.

Based on the described models and the behavior / relationships between them we have created several databases which brought together create a sportsman-centered system where the information is well defined and structured.

For example the relation and behavior between a sportsman and equipment is properly

defined by the verb *to use*. The verb is given by either the fact that a sportsman uses equipment during his exercises / workout, either by a coach who describes the equipment to his students either by researchers which studies new techniques to improve existing equipments or to create new ones.

As described in the previous example the sportsman as system central point can be replaced by coaches, researchers and why not but novices in the field. In these other cases the systems stays intact but the relationships between entities and their behavior is changed.

In the next article sections we propose a design model for the bodybuilding database in order to assure the data correctness and its feature as an open system.

4. Bodybuilding exercises

In bodybuilding many exercises and programs are well known and include:

- the week days;
- the working groups of muscles;
- the exercises to be executed;
- the number of sets;
- the number of repetitions per each set;
- the used body weight lifting.

In the specialized literature, many resources have in their structure and/or in chapters' information like:

- basic concepts
- human body topologies
- group of muscles and their afferent exercises
- different program composition techniques
- alimentation and supplements
- risks during workouts
- competitions and their assessments criteria
- the presentation of important competitions

For their current / daily activity sportsman, coaches, scientists and managers have to have a database of bodybuilding exercises fulfilling the next requests:

- must be complete - it must contain all the exercises and their execution variations;
- must be valid – must contain only data that is given by specialists, validated in practice and with a scientific background so all the people from the bodybuilding society should accept it and confirmed it as a new standard;
- must be open – a database feature that has the capability to assimilate new elements which appear once the evolution of the BB is in progress;
- must offer the sources from where all the information is gathered and stored in database so the ones who want to study in depth the subject should have all the resources ready in order to gain some time.
- must allow flexible searching of data by one or more criteria, so that sportsman and technicians to quickly access the features they need, and that the data provided should at least coincide with the requirements.
- must have a high degree of consistency, without including contradictory items that have a negative effect on those who identify ambiguous situations just because of a negation and affirmation from a few rows further.

The exercises database will include records which contain:

- a unique key associated with each exercise; the key is used in the redundancy management of complex application where other exercises databases are included

- the complete name of the exercise
- the exercise description as a standard text structure containing:
 - the starting position of the body,
 - execution phases, timelines, risks,
 - the required equipment, images,
 - groups of muscles involved
 - the degree of complexity
 - the exercises order within a workout
 - animated images or movies with the exercise execution by great sportsman during their workout
 - number of repetitions, warnings about common mistakes,
 - tips for proper and effective executions
 - how devices fits the sportsman dimensions
- workout level in which the exercises are integrated (beginners, professionals, advanced)
- the involved group of muscles
- the required device / equipment
- risks
- bibliography

In Figure 2 we present the table were the exercise related information is stored. Below we describe the columns description:

Column Name	Data Type
id	INT(10)
version	DECIMAL(3,3)
exercise_name	VARCHAR(255)
description	TEXT
muscle_group_target	INT(3)
exercise_type	INT(3)
equipment_type	INT(3)
force_type	VARCHAR(50)
workout_level	INT(3)
mechanism_type	INT(3)
media	INT(10)
media_chain_id	INT(10)
risks	TEXT
resources	INT(10)
status	INT(3)
created	TIMESTAMP
last_updated	TIMESTAMP

Fig. 2. The “exercises” table

In Table 1 we describe the columns data types and short descriptions:

Table 1. Exercises table structure

No.	Column name	Description
1	id INT(10)	the exercise identifier which together the version column compose the table primary key
2	version DECIMAL(3, 3)	the record version. (We define the usage of this column here, only once, and is to be taken into account for each table where the column is present) In order to keep track of each record changing this column is updated accordingly. The column was introduced for historical analysis and future predictions – based on historical evolution & analyses.
3	exercise_name VARCHAR(255)	the full name of the exercise
4	description TEXT	as described in the previous paragraph, this should contain the main information about the current exercise
5	muscle_group_target INT(3)	a foreign key to the muscle groups table. This table holds the name of the muscle groups which are to be affected by a certain exercise at a given time
6	exercise_type INT(3)	a foreign key to the exercise types table. This table contains all the exercise types that a sportsman can perform
7	equipment_type INT(3)	a foreign key to the equipment types table. This table contains all the equipments types
8	force_type VARCHAR(50)	defines the type of the force that is to be used during the exercise. Can contain values like: Push, Pull, Static, N/A.
9	workout_level INT(3)	– a foreign key to the workout level table. This table contains information about the level of the sportsman for doing the current exercise. Can be: Beginner, Intermediate, Professional, Advanced, etc
10	mechanism_type INT(3)	a foreign key to the mechanism types table. This table contains information about the mechanism (Compound, Isolation) used during exercise.
11	media INT(10)	a foreign key to the media table. This table contains all media used in exercise describing and exemplification
12	media_chain_id INT(10)	a foreign key to the media chain tables. This table contains media chains – like music playlists – in which media (images, videos and audios) are chained in order to follow the sportsman during each exercise steps / phases
13	risks TEXT	contains the risks to whom a sportsman is exposed during exercise
14	resources INT(10)	a foreign key to the resources tables. This table has a child table where resources / docs / links / bibliography are stored. From these resources the exercise information is extracted and/or future references are to be found

No.	Column name	Description
15	status INT(3)	a foreign key to the statuses table. This table contains global purpose statuses that are to be used by each record to establish its status
16	created TIMESTAMP	the timestamps when the record is created
17	last_udpated TIMESTAMP	the last update timestamps

In order to realize a stable database regarding the operations of reorganization due to incorrect definition of the length fields, we proceed as follows:

- create lists (custom tables) for exercises, muscle groups, the equipments,
- all exercises are to be described in a standard and simple manner
- images stocks for all exercises executions are to be build. These image stocks have in their composition the maximum number of images required for a better and exact understanding on how the exercise must be executed in order to be efficient
- the most common requests is determined to find keys for selecting the articles and also methods of composing queries (exercises that address a class of muscles, exercises that are executed with a particular device, which exercises are performed sitting or lying in)

In order to support the described steps we propose the next database design. First we describe the table's structure after which we present an overview of the whole system in which the relationships between tables are shown.

- **Status** table which contains all the records statuses is described in next figure:

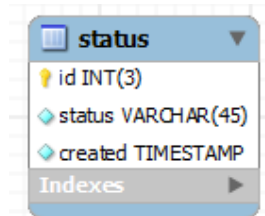


Fig. 3. The "status" table

This table contains statuses which are to be used by any record from bodybuilding database for defining its status at a given time. This is an initial list and can be easily extended by adding new statuses for defining a custom scope.

Table 2. Status table structure

No.	Column name	Description
1	id INT(3)	The unique identifier. Is the primary key
2	status VARCHAR(45)	The status itself. For now we define the next statuses: - Active - - Inactive - Deleted - Archived - Invalid
3	Created TIMESTAMP	The date & time when the record was created

- **Equipment type table****Table 3.** The "equipment_type" table

The screenshot shows a table definition for 'equipment_type' with the following columns:

- id INT(10) (Primary Key)
- version DECIMAL(3,3)
- equipment_type VARCHAR(50)
- created TIMESTAMP
- last_update TIMESTAMP
- status INT(3)

There is also an 'Indexes' section at the bottom of the window.

This table contains the list of equipments which can be used by a sportsman during an exercise or a workout. We present the most important equipments but the list can be easily updated, by adding new records in these tables, with new ones.

Table 4. Equipment type table structure

No.	Column name	Description
1	id INT(10)	The unique identifier of the table. Is a part of the primary key.
2	version DECIMAL(3,3)	The version of the record (the use of this record was already explained early in article). Is a part of the primary key.
3	equipment_type VARCHAR(50)	The equipment type. We define only the most important types: <ul style="list-style-type: none"> - Bands - Barbell - Body Only - Cable - Dumbbell - E-Z Curl Bar - Exercise Ball - Foam Roll - Kettlebells - Machine - None - Other
4	created TIMESTAMP	The date and time when the record is created
5	last_updated TIMESTAMP	The date and time when the record was last updated
6	status INT(3)	The record status. (see Status table)

- **Exercise type** table which contains all the important exercise types.

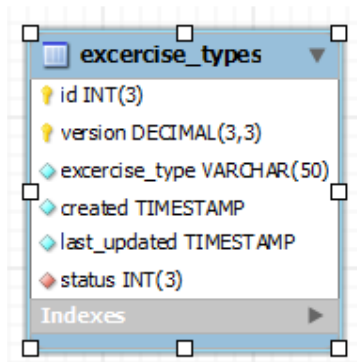


Fig. 4. The "exercise_type" table

Below we describe the table columns data types and columns descriptions:

Table 5. Exercise_type table structure

No.	Column name	Description
1	id INT(3)	The record identifier (part of the primary key)
2	version DECIMAL(3,3)	The record version (part of the primary key)
3	exercise_type VARCHAR(50)	The exercise type. We define the most important ones: - Cardio - Plyometrics - Strength - Stretching - Other
4	created TIMESTAMP	The date and time when the record was created
5	last_update TIMESTAMP	The date and time when the record was last updated
6	status INT(3)	The record status. (see Status table)

- **Mechanics type** table which contains the main exercises mechanics type

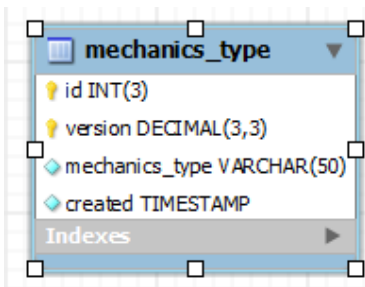


Fig. 5. The "mechanics_type" table

Below we describe the table columns data types and columns descriptions:

Table 6. Mecanics_type table structure

No.	Column name	Description
1	id INT(3)	The record identifier – part of the primary key
2	version DECIMAL(3,3)	The record version – part of the primary key

3.	mechanics_type VARCHAR (50)	The mechanics type: - Compound - Isolation - N/A
4	created TIMESTAMP	The date and time when the record was created

- **Muscle groups** table contains the main groups of muscle that can be affected during an exercise.

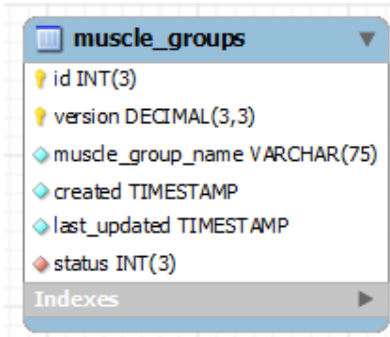


Fig. 6. The "muscle_groups" table

Below we describe the table columns data types and columns descriptions:

Table 7. Muscle_groups table structure

No.	Column name	Description
1	id INT(3)	The record identifier – a part of the primary key
2	version DECIMAL(3,3)	The record version – a part of the primary key
3	muscle_group_name VARCHAR(75)	The name of the muscle group. We define the most important groups: - Abdominals - Abductors - Adductors - Biceps - Calves - Chest - Forearms - Glutes - Hamstrings - Lats - Lower Back - Middle Back - Neck - Quadriceps - Shoulders - Traps - Triceps
4	created TIMESTAMP	The date and time when the record was created
5	last_update TIMESTAMP	The date and time when the record was last updated.
6	status INT(3)	The record status. (see. Status table)

- **Workout level** table which describes the level of the sportsman in order to perform the selected exercise or workout

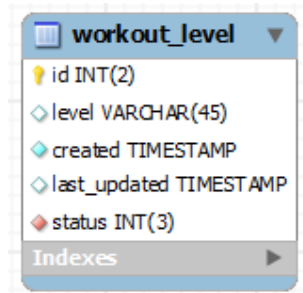


Fig. 7. The "workout_level" table

Below we describe the table columns data types and columns descriptions:

Table 8. Workout_level table structure

No.	Column name	Description
1	id INT(2)	The record identifier – the table primary key
2	level VARCHAR(45)	The sportsman level. We defined the most important ones: - Beginner - Expert - Intermediate
3	created TIMESTAMP	The date and time when the record was created
4	last_updated TIMESTAMP	The date and time when the record was last updated
5	status INT(3)	The record status. (see Status table)

- **Media** table which holds information about all the media used to describe an exercise or in its description.

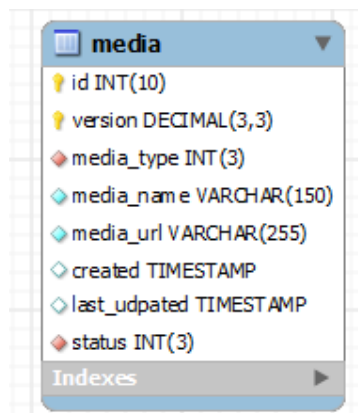


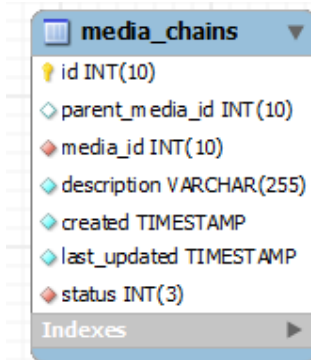
Fig. 8. The "media" table

Below we describe the table columns data types and columns descriptions:

Table 9. Media table structure

No.	Column name	Description
1	id INT(10)	The record identifier – is part of the primary key
2	version DECIMAL(3,3)	The record version – is part of the primary key
3	media_type INT(3)	A foreign key to the media type table which contains the primary media types such as: file, audio, video, other
4	media_name VARCHAR (255)	The name of the stored media. This could be a generic name or the actual filename of the stored media
5	media_url VARCHAR(255)	The media url or path. If the media is stored on a third party server then its URL it's stored otherwise the local physical path
6	created TIMESTAP	The date and time when the record was created
7	last_update TIMESTAMP	The date and time when the record was last updated
8	status INT(3)	The record status

- **Media chains** table. This table contains information about eventual media chains that are created during an exercise or a workout. We define a media chain to be a media suite ordered in chronological or other order. Example: an exercise has, lets say, 3 phases and for all you have to show one or multiple images. These images must come in a certain order so in order to keep it simple we define a so called chain of media.

**Fig. 9.** The "media_chains" table

Below we describe the table columns data types and columns descriptions:

Table 10. Media_chain table structure

No.	Column name	Description
1	id INT(10)	The record identifier – table primary key
2	parent_media_id INT(10)	A foreign key to the media table. The parent of a media record in a chain. In case of the first record in the chain the parent is null otherwise will be the previous media.
3	media_id INT(10)	A foreign key to the media table. This is the actual "chain bubble".
4	description VARCHAR(255)	The media short description.
5	created TIMESTAMP	The date and time when the record was created

6	last_updated TIMESTAMP	The date and time when the record was last updated
7	status INT(3)	The record status (see. Status table)

- **Resources** and **Resource entry** tables. These two tables are used to define the resources (links, books, articles) from where the exercise information is taken – for future research or reading or sportsman, coaches or researchers.

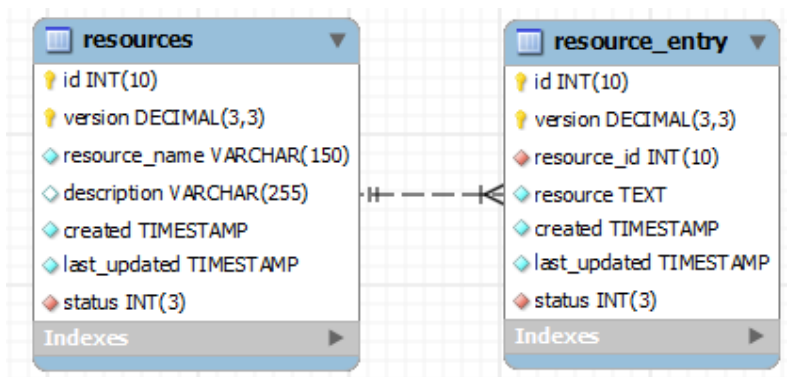


Fig. 10. The "resource" and "resource_entry" tables

Below we describe the *resources* table columns data types and columns descriptions:

Table 11. Resource table structure

No.	Column name	Description
1	id INT(10)	The record identifier – part of the table's primary key
2	version DECIMAL(3,3)	The record version – part of the table's primary key
3	resource_name VARCHAR(150)	General resource name
4	description VARCHAR(255)	Resource description
5	created TIMESTAP	The date and time when the resource was created.
6	last_updated TIMESTAMP	The date and time when the resource was last updated.
7	status INT(3)	The resource status (see Status table)

Below we describe the *resource_entry* table columns data types and columns descriptions:

Table 12. Resource_entry table structure

No.	Column name	Description
1	id INT(10)	The record identifier – part of the table's primary key
2	version DECIMAL(3,3)	The record version – part of the table's primary key
3	resource_id INT (10)	A foreign key to the resource table – is the link between the entry and its parent resource
4	resource TEXT	The resource itself. This can contain from plain text files, article parts to links, page numbers, references, etc.
5	created TIMESTAP	The date and time when the resource entry was created.
6	last_updated TIMESTAMP	The date and time when the resource entry was last

No.	Column name	Description
		updated.
7	status INT(3)	The resource entry status (see Status table)

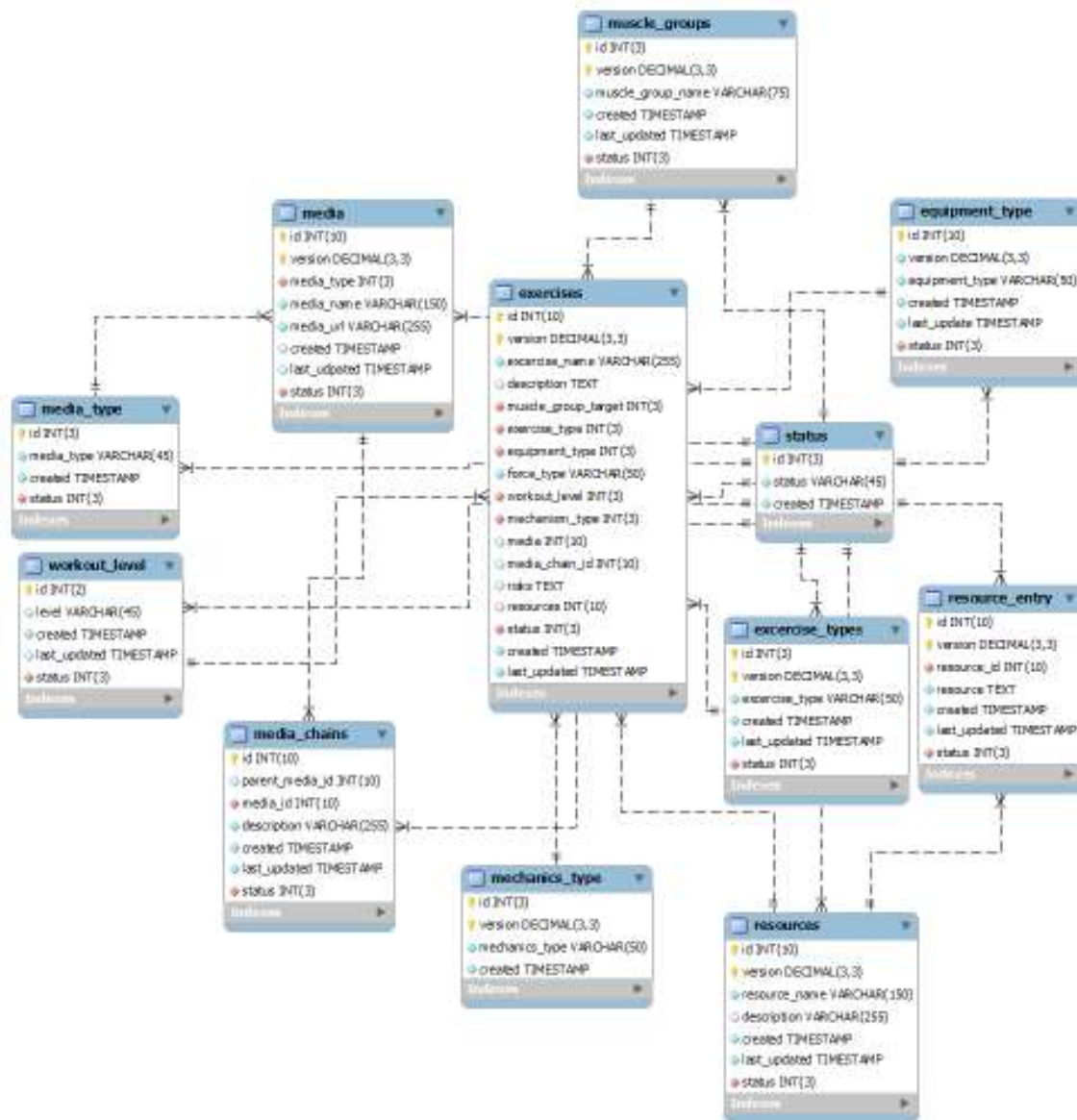


Fig. 11. Exercises database design

In Figure 11 we present an overall picture of the exercises database and the relationships between tables.

5. Application Design

Besides the bodybuilding system conceptualization presented in third section and the exercises database design and structure presented in fourth section we present also an application architecture proposal.

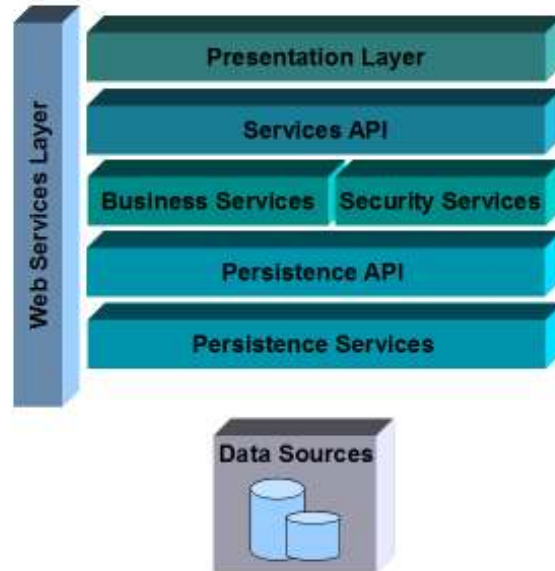


Fig. 12. Application Architecture

As shown in Figure 12, we propose a Service Oriented Architecture which provides a loosely-integrated suite of services that can be used within multiple separate systems from several business domains. [5]

The system is to be developed using the latest open source technologies such as:

- Java – as the programming language
- Spring framework – *an open source application framework for the Java platform* [4] upon which the application is build
- Hibernate – *is an object-relational mapping (ORM) library for the Java language, providing a framework for mapping an object-oriented domain model to a traditional relational database* [6]
- MySQL – *a relational database management system (RDBMS) ... that runs as a server providing multi-user access to a number of databases* [7]

Knowing the proposed technologies and architecture the system has the next key features:

- Can run on every operating system
- Modules can be added or removed without affecting the whole system
- New functionalities can be added through the provided API.
- Different client applications can be build using different technologies. A client can be either a usual computer or a mobile device. This feature is given by the web services layer.
- Is an open system. This feature is assured through the exposed web services and API's.

6. Conclusions

The bodybuilding field is a complex system containing huge amount of information which must be gather and concentrated into a single common database. This database is designed only once, defined and promoted as a standard and as an open system.

Being an open system, the information can be accessed and updated by everyone from sportsman, coaches, equipment manufactures, competitions organizers to researches and usual people.

The populating process is assured by a big number of persons and started with whatever exists for now in the field. The information is to be taken from specialized literature, sportsman and coach's experience, existing and validated databases.

The information quality is assured by the simplicity of the digital content but to ensure its completeness and uniformity is a difficult task. So, in this direction the information which is introduced from different sources is first validated and if passes the validation process is mark as valid and made public. In case of not yet validated data, the information is also made public but mark as not validated - is in beta phase.

Based on existing design and keeping in mind the fact that this must be easy to use and accessed by a huge number of people, usable user interfaces (administrative console application) can be build in matter of minutes using specialized open source tools.

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Author

Vasile-Laurențiu CIOVICĂ has graduated the Faculty of Science, in 2008 gaining a Bachelor of Science degree in Information Technology with a thesis on Translators and Interpreters for Code Generation and Software Optimization. In 2010 he gained a Master of Management degree in the field of Cybernetics, Statistics and Economic Informatics with a thesis on Intelligent Agents. He is currently a PhD student at Academy of Economic Studies in Bucharest. Between 2006 and 2010 he worked as a programmer at a company from Sibiu. Since January 2010 he works as an Independent Consultant. He is the author and co-author of more than 12 scientific articles in the field of software quality and optimization, code generation techniques, collaborative systems, data bases, programming environments and techniques, mobile platforms and economic informatics systems. Besides the scientific activity he is also an active software developer, being the author of few applications. Some of the created applications were presented to different student's scientific conferences where he was distinguished with 1 excellence award, 6 first awards, 1 second award and 2 third awards. His area of interests includes among others: software quality, optimization techniques and algorithms, code generation techniques, economic informatics systems, intelligent and collaborative systems, mobile platforms.