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SUPPLY OF MEASUREMENT RESULTS OF SPRING WIRE TESTS ON THE INTERNET

M. Braunschweig / M. Weiß / K. Liebermann

TU Ilmenau

ABSTRACT

Within the scope of a research project, extensive measurements for the determination of spring wire properties relevant for operation and production were carried out [1]. To provide the properties and characteristics accessibly for companies involved in the project, a SQL-database to store the measurement results was developed. The User-Interface is a Website, no special software has to be installed. The paper presents the new software technologies which allow it to develop very well structured modules with high flexibility for the Website. This is necessary because the companies use the measuring data entirely different. In addition in the future new tests are developed and the database structure is dynamic.
The following software technologies should be discussed:

- ASP.NET MVC 3 Framework from Microsoft
- JavaScript and Ajax
- LINQ and Data Visualization with Charts

The goal is to create the highest quality, most robust, simple and maintainable code possible [2].

Index Terms - spring steel wire, database, SQL, Website, ASP.NET MVC 3 Framework, LINQ to SQL, chart

1. INTRODUCTION

Within the scope of a research project, extensive measurements for the determination of spring wire properties relevant for operation and production were carried out [1]. To store the measured data (characteristics) and the calculated material properties and to make it accessible for companies involved in the project, a SQL-database was developed. The User-Interface is a Website, no special software has to be installed and the results are available on any web-enabled device, such as PC or Smartphone. Fig. 1 shows the flow of measuring data.

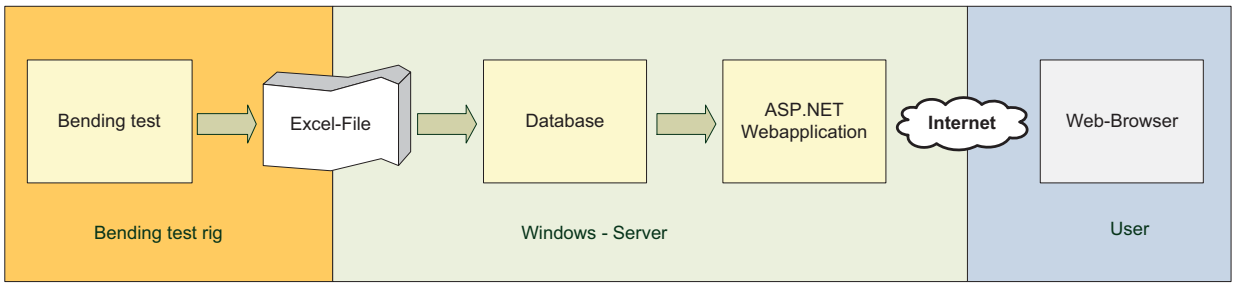

Fig. 1: Principle of flow of measuring data

2. SQL-DATABASE FOR SPRING WIRE CHARACTERISTICS

The structure of the generated spring wire database results from the following requirements:

- Storage of material data, including manufacturer's specifications
- Storage of all wire pretreatment steps
- Storage of measurement conditions
- Storage of the complete measurement data (stress- deformation graphs)
- Storage of calculated material properties

The current spring wire database is shown in Fig. 2. Some tables that meet the above requirements are especially highlighted. It is also worth mentioning, that this structure is not static, it must be adjusted during the research project. Therefore it is necessary to make the software structure very flexible. With LINQ = Language Integrated

Query, especially LINQ to SQL the flexibility is ensured very well for the database queries. The advantage of using LINQ will be discussed later.

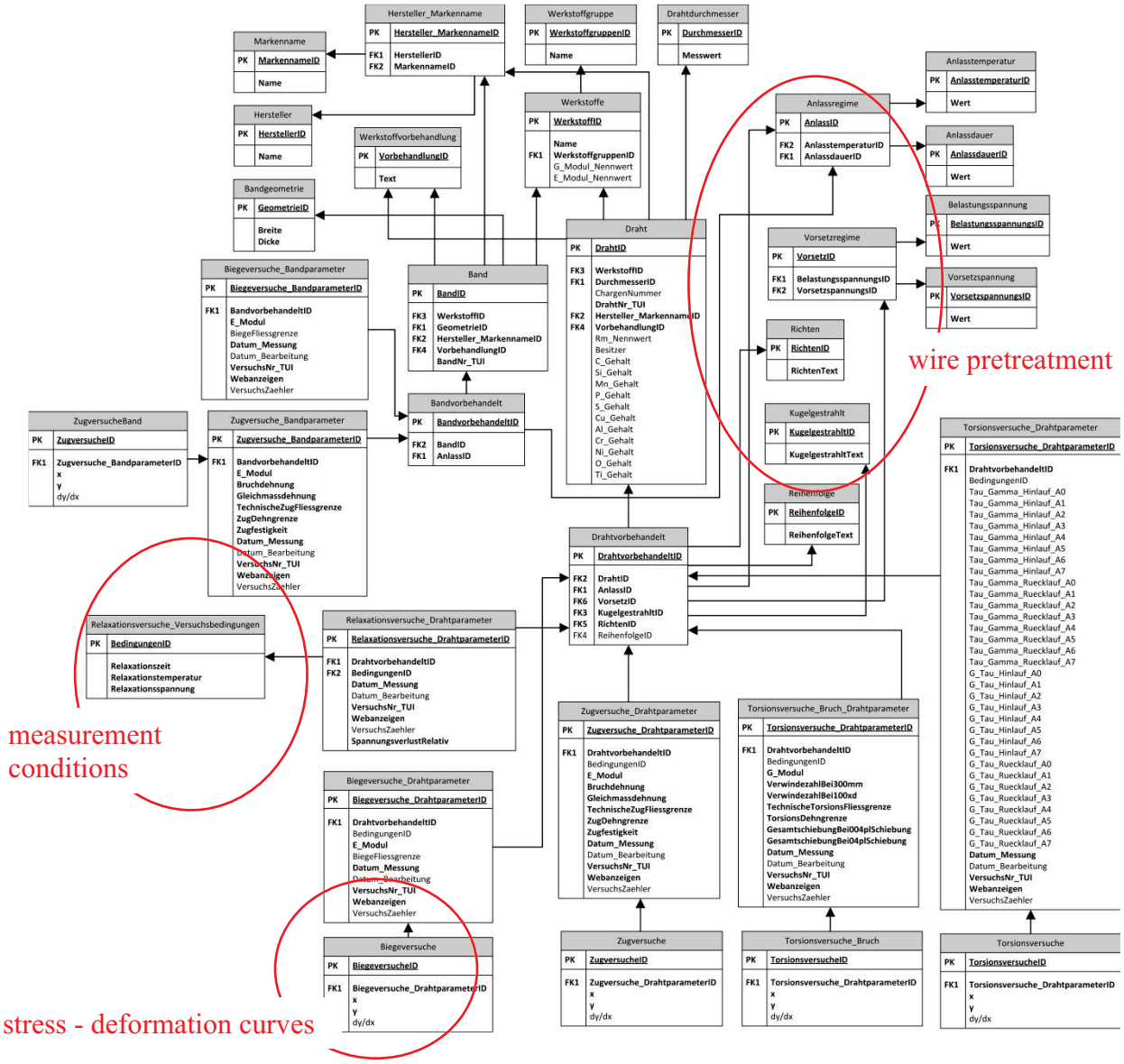

Fig. 2: Structure of the spring wire database

3. CHOOSING THE SOFTWARE STRUCTURE

There was a consistent separation of the presentation of the data (User Interface = UI) and the application, often called Domain Logic. In the Domain Logic the information retrieval is performed. The User Interface is a Website. For the realization of the Web-UI (Browser-based User Interface) three different technologies were compared.

- ASP.NET and Web Forms
- Rich Internet Applications (RIA) with Silverlight
- ASP.NET MVC 3

With ASP.NET and Web Forms you can create Web pages relatively quickly. The programming is due to the use of control objects very similar to the creation of a Windows-Program. But the software structure can be confused

in larger projects, for example by the principle of AutoPostBack and the mechanism of connecting client-side events with server-side event handler code. The amount of date to be transmitted between the server and the client is often large [2]. A reduction in the amount of data to be transmitted can be achieved through the use of Ajax (Asynchronous JavaScript and XML). An example of the use of Ajax is explained in section 6.1.

Silverlight allows the browser for example 3D effects and animations. To access data from a database the Client/Server principle is used, for example using WCF RIA Services (WCF = Windows Communication Foundation, RIA = Rich Internet Application). So you can create very powerful applications. Since in the proposed project no 3D effects or animations are important, the complex structure with Silverlight and WCF RIA Services was not considered further.

ASP.NET MVC version 3 pursues the principle of consistent separation of the various program tasks within the User Interface. The acronym MVC means Model – View – Controller. You are again separating the representation of data (View) and the other tasks of the program. The MVC-Framework achieves a clear program structure, the program is easily maintainable and expandable. The following example shows this. A very good performance of the Web application is also achieved [2].

4. SOFTWARE STRUCTURE BASED ON THE ASP.NET MVC 3 FRAMEWORK

The components Model, View and Controller will be explained using the example of the spring wire Website.
The following part of a View (HTML page) shows the possibility to render dynamic output to the User-Interface. The application data can be accessed through the Model. The view is created with the help of the "Razor" view engine [3]. This allows including C# - code on the HTML page and so the dynamic output.

Model: Class for measuring task as example

```
public class MeasuringTask
     {
          public Drahtvorbehandelt drahtvorbehandelt { get; set; }
          public String versuchsArt { get; set; }
          public int drahtParameterId { get; set; }
          public string datumMessung { get; set; }
     }
```

View: Part of HTML code

```
@foreach (var item in Model) {
    <tr>
        <td>
            @item.versuchsArt
        </td>
        <td>
            @item.drahtvorbehandelt.Draht.Hersteller_Markenname.Hersteller.Name
        </td> ...
```

The full HTML code produces the Website shown in Fig. 3.

Fig. 3: Website for selection of tests

A controller class is responsible for the application logic. It consists of a number of action methods that process incoming requests and handle user input and interactions [3]. An action method typically calls a separate view component to generate HTML Code (see listing).

```
public ActionResult Versuche(Selection selection)
 {
   List<MeasuringTask> measuringTasks = new List<MeasuringTask>();
   if (selection.TorsionsversucheBisBruch == true)
   {
     var versucheliste = from v in wireRepository.Data.Torsionsversuche_Bruch_Drahtparameters
         where v.Drahtvorbehandelt.Draht.DrahtID == selection.DrahtId && v.Webanzeigen == true
         orderby v.Drahtvorbehandelt.Anlassregime.Anlassdauer.Wert
         select v;
         foreach (var v in versucheliste)
         {
                   MeasuringTask task = new MeasuringTask();
                   task.drahtvorbehandelt = v.Drahtvorbehandelt;
                   task.datumMessung = v.Datum_Messung;
                   task.drahtParameterId = v.Torsionsversuche_DrahtparameterID;
                   task.versuchsArt = "Torsionsversuch bis Bruch";
                   measuringTasks.Add(task);
          }
   }
   return View(measuringTasks);
 }
```

Access to the data from the database is done through classes that were generated with the help of LINQ to SQL. The advantage of mapping database tables to classes will be explained in the next section.

5. WORKING WITH DATA: LINQ TO SQL

ORM = Object-relational mapping is a programming technique to exchange between an object-oriented language and a relational database. For SQL databases there are two programming techniques from Microsoft available (in addition to solutions from other companies):

ADO.NET Entity Framework
LINQ to SQL (LINQ = Language Integrated Query)

Both are very powerful components of the .NET Framework for managing relational data as objects. ADO.NET Entity Framework was developed later, but is more powerful. It can also be used for other than SQL databases, e.g. for Oracle databases or IBM DB2. In the program for the Website with a SQL database LINQ to SQL is used. Fig. 1Fig. 4 shows some tables of the database with the associated classes, generated with LINQ to SQL.

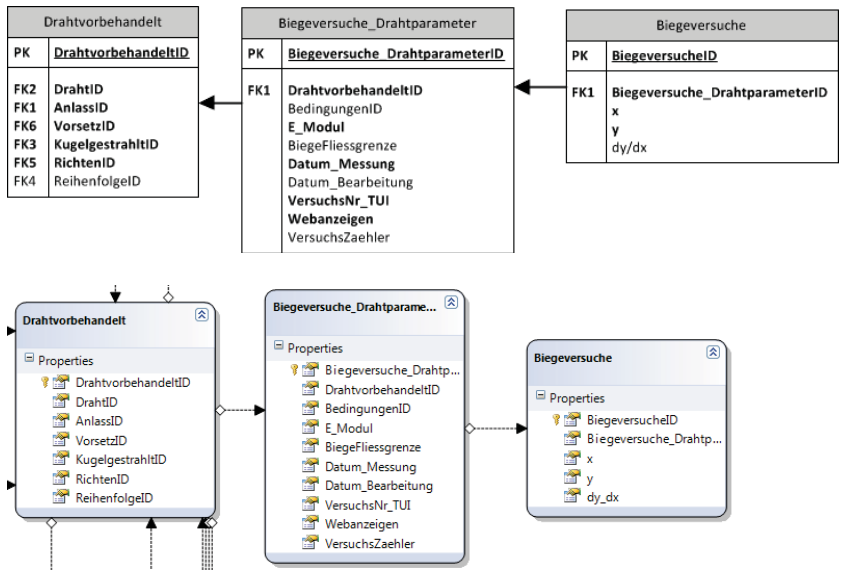

Fig. 4: Some tables of the database with relationships (above) and the associated classes (below)

In both techniques access to a relational database is realized with strongly-typed queries with LINQ.
So the database queries are simple and the compiler makes an error check.
Example for a LINQ Query:

```
var versucheliste = from v in wireRepository.Data.Torsionsversuche_Bruch_Drahtparameters
       where v.Drahtvorbehandelt.Draht.DrahtID == selection.DrahtId && v.Webanzeigen == true
       orderby v.Drahtvorbehandelt.Anlassregime.Anlassdauer.Wert
       select v;
```

The Visual Studio 2010 from Microsoft supports developers very well in creating the classes for the database. For future work the use of the ADO.NET Entity Frameworks should be tested.

6. IMPROVEMENTS TO THE WEB-UI

6.1. JavaScript and Ajax for dynamic content and shorter page load times

Using JavaScript it is possible to validate user input or to change the content of a Website due to user interactions. JavaScript runs on the client. If no data from the server are required, there is no communication between server and client.
Another field of application is sending and receiving data from the server without reloading the full page from the server. This technology is called Ajax = Asynchronous JavaScript and XML. On the introduced Website Ajax will be used for example to fill the Dropdown lists for wire selection depending on the previous selection, e.g. depending on the material group selection (see Fig. 5). The page will not be reloaded completely, so the access times are reduced. Also these technologies give your site a desktop-like behavior.

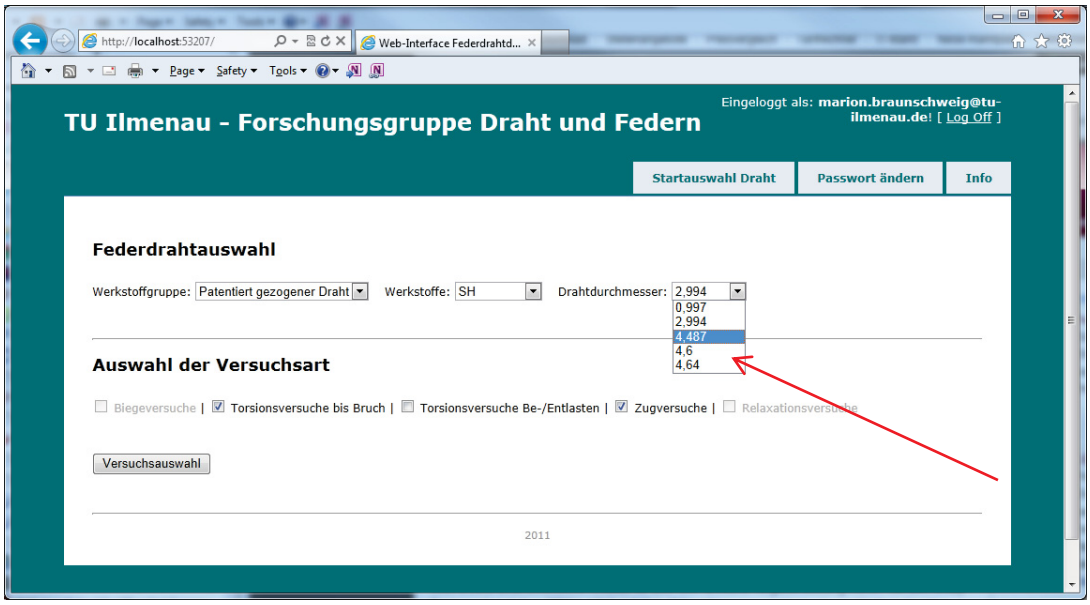

Fig. 5: Dropdown lists with dynamic content

To simplify the programming with JavaScript, there are a number of libraries. For example the JavaScript Library jQuery is very powerful [4][5]. jQuery is a fast and concise JavaScript Library. jQuery simplifies HTML document traversing, event handling, animating, and Ajax interactions [4]. The following example of program code shows, how to use jQuery for the Ajax interaction running, if the user selects a new value from the dropdown list for material (Werkstoffe).

```
$(function () {
      $("#Werkstoffe").change(function () {
           var ws = { Name: $("#Werkstoffe").val() };  // name of material
           var rootdir = "@Url.Content("~/")";
           $.ajax({
                type: "POST",
                url: rootdir + "Home/DrahtAuswahl",
                data: JSON.stringify(ws),
                dataType: "json",
                contentType: "application/json; charset=utf-8",
```

```
                    success: function (data, status, req) {
                        $("#Diameter").empty();
                        for (var k = 0; k < data.length; k++) {
                            $("<option/>").val(data[k]).text(data[k]).appendTo("#Diameter");
                        }
                        $("#Diameter").change();
                    },
                    error: function (req, textStatus, errorThrown) {
                        alert("Error: " + req.status);
                    }
                });
            });
        });
```

Data necessary for interaction are not represented with XML (Extensible Markup Language) but with JSON. JSON = JavaScript Object Notation, like XML is a text format, readable for human and machine. JSON is more compact and the data are typed, with only some basic types supported. Other hand, XML is a markup language and universally applicable.
Example for the representation of data (wire diameter and material) with JSON format:

```
{
    "Wert": "0,997",
    "Material": "SH"
}
```

jQuery and JSON are well supported in the ASP.NET MVC 3 Framework. Therefore, they are used here.

6.2. Charts for visualization of measuring data

The measurement results are made available to users in form of charts.
The new class Chart from the .NET Framework 4.0 simplifies the software development. Fig. 6 shows a chart for the complete stress-deformation characteristics and the first derivation of these characteristics for different temperatures for torsional tests.

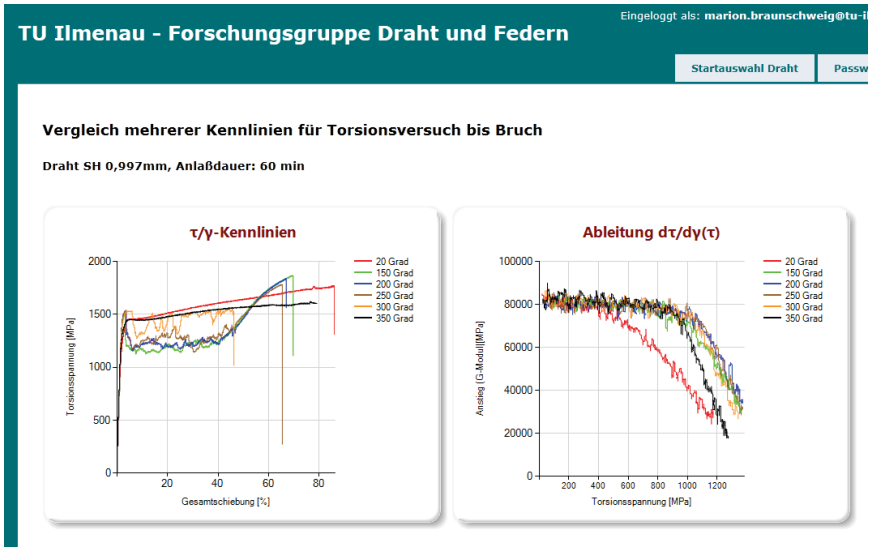

Fig. 6: Example for charts generated with class Chart: Characteristics for different temperatures

The chart is generated in the program, saved as image and placed on the Website. The code demo shows how to save the chart as image.

```
public static FileContentResult GetChartResultAsImage(Chart chart)
        {
            var imageStream = new MemoryStream();
            chart.SaveImage(imageStream, ChartImageFormat.Png);
            return new FileContentResult(imageStream.ToArray(), "image/png");
        }
```

When developing the software for the visualization, the possibilities for the user interactions are to be improved, for example the possibility to zoom. The .NET classes are becoming more powerful. It may be that the classes provide this functionality in future.

7. SUMMARY

The result of the introduced work is a spring wire database with special material properties and characteristics that is available over the internet. The new software technologies allow a quick change and extension of the User-Interface to fulfill the requirements of the users to the actual use of the data.

8. REFERENCES

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