QSA scripting for (semi-)automatic valve train simulation

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QSA scripting for (semi-)automatic valve train simulation

Overview

- Schaeffler Group
- Background
- QSA tool
- Programming details
- Summary
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Schaeffler Group

| Employees worldwide: approx. 67,500 | Sales 2010 worldwide: 9.5 bn euros | 180 locations in more than 50 countries |

Map showing locations of employees and distribution of products (LuK, INA, FAG) worldwide.
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Background

- Dynamic simulation of valve trains since 1994 at Schaeffler
- Semi-automatic in-house DOS tool exists since 1998
  - Advantages:
    - easy, comprehensible input (one text file)
    - post processing integrated
  - Disadvantages:
    - simplified MMS valve spring (one body/coil)
    - no enhancements of model

- Requirements for similar SIMPACK tool:
  - as easy to use as previous tool
    - fast and comprehensible
    - one input data sheet
    - automatic post processing
  - up-to-date spring modeling
  - prepared for RFF, tappet, type V, rocker arms, complete camshaft, …
  - handling of different versions of database (model, scripts)
  - …
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QSA tool

- QSA chosen for realization
- tools are accessed from post processor
- access by additional icons

Project handling | Create/verify valve spring | Single valve train simulation incl. pre/post processing | PPT export | Set working cycle
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QSA tool

Project handling

Tasks:
- create new project / choose existing project
- set current project
- create directory structure of new project
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QSA tool

Tasks:
- create valve spring from center line
- run dynamic simulation
- automated post processing (force, frequency)
- prepare for simulation (set to installation length)
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QSA tool

Tasks:
- handling of approaches, create approach from in-house kinematic software
- run kinematic/dynamic simulation
- bi-lingual post processing
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Programming details

Scripts written in cooperation with Intec GmbH/SIMPACK AG

Complexity

- 11 files
- 140 functions
- 12,000 lines of code

Challenges

- new programming language QSA
- handling of different database versions
- feedback on progress of simulation
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Programming details

New programming language QSA

- **QT Script for Applications** (invented by Trolltech)
- simple and easy (comparable to Python)
- good help system
- complete set of control statements (including exception handling)
- nearly everything is possible or can be done by calling a shell command (e.g. for registry access or DDE commands)
- GUI capability is limited/inconsistent
  - no pictures
  - arrangement of widgets limited
  - in some widgets HTML syntax (font, size, color) of text is enabled (e.g. MessageBox, PushButton.label), in others it isn't (PushButton.text, GroupBox.title)
  - some widgets allow event triggered actions (e.g. LineEdit), others don't (ComboBox)
- inconsistent set of commands
  - e.g. `match()`, `find()`, `search()`, `startsWith()`, `endsWith()` can be used for same purpose
  - array indices can be defined by strings, e.g. `array["text"] = 1`, but a list of the indices is not provided
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Programming details

Handling of different database versions

- Requirement: Always ensure access to existing projects
- Solution: Save database version of project and access QSA scripts of related database using a wrapper. SIMPACK script directory contains only one file "wrapper.qs" to manage database handling.

```javascript
function WRAPPER_svt() { // called by GUI
    // get database version
    dbVersion = WRAPPER_readDBFile();
    // set global variables
    WRAPPER_setGlobalVars(dbVersion);
    // read scripts of db version of project
    WRAPPER_readScripts(dbVersion);
    // call function in database, function
    // needs to be defined in each database
    SVT_main();
}

function WRAPPER_readScripts(dbVersion) {
    // define paths where to find scripts
    Script.resetSearchPath();
    Script.addSearchDir("C:/"+dbVersion)
    // read all scripts
    Script.include("script1.qs");
    Script.include("script2.qs");
    ...
}

function WRAPPER_setGlobalVars(dbVersion) {
    switch (dbVersion) {
        case "2009-06-16":
            globalVar1 = 1;
            globalVar2 = 100;
            ...
            break;
        case "2009-10-20":
            globalVar1 = 2;
            globalVar2 = 300;
            ...
            break;
        ...
    }
}
```

// define global vars of all databases,
// otherwise post processor crashes
var globalVar1;
var globalVar2;
...
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Programming details

Feedback on progress of simulation

- Requirement: User feedback while simulation is running in background
- Solution: Run SIMPACK in asynchronous mode

```javascript
function callSimpackAsync(command) {
    var p = new Process;
    var out = "";
    var cmd = System.getenv("SIMPACK") + "/simpack/sys/win32/msys/bin/sh -t -c "'+command+'";
    p.arguments = cmd.split(" ");
    p.start();
    while (p.running) {
        for (var i=0; i<100000; i++) {}         // sleep
        out += p.readStdout();                  // get output from stdout
        // print last 20 lines of 'out' (otherwise just beginning of text is shown)
        textEdit_UserInfo.text = last20LinesOfText(out);
    }
}
```
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Summary

Resume after nearly two years of usage
A tool as easy to use as the former tool was created using QSA with the following additional advantages:
- user-optimized handling (GUI)
- effort to adapt tool to new version of SIMPACK 8.9xx takes 5 minutes
- enhancements of model (e.g. complete system) are possible
- better model of valve spring
- duration of a standard project was reduced by 20%

Planned enhancements
- type V and rocker arm models
- support to build up camshaft with associated valve trains

SIMPACK requirements
- revision of QSA language, e.g. triggered actions for ComboBox widget, consistent set of commands
- faster handling of result files in post processor
Together we move the world.
So you can move the world.

Thank you for your attention.