Reference Projects

Last update: 2025-Apr-26

designXtronics
Roman Frank Starbek

PHILOSOPHY

SMART – create products that are characterized by a high intelligence content

SIMPLE – just implement what's needed, not what's possible

SWIFT – success projects with a great amount of experience

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PROJECTS (Extraction)

2024 – 2025 **"Safety Controller" software design for fuel cell systems** – GLOBE Fuel Cell Systems GmbH (Stuttgart)

Period: 6 months

Content: Requirements Engineering for safety function modules: requirements analysis and formalization into defined pattern with the aim of 100 % verification, check of formalized requirements against consistency and gaps with MATLAB-Tool *Requirements Verifier*, automatic software unit generation based on formalized requirements with *Requirements Verifier*; design of the application software architecture and implementation of generated models in Simulink; unit tests of safety function modules with MATLAB-Tool *Model Tester*: specification of unit tests, carrying out of reproducible regression tests (Model-in-the-Loop), automatic detail and overview report generation; process documentation aligned to DIN EN ISO 13849

Tools: MATLAB/Simulink/Stateflow, designXtronics *Requirements Verifier*, designXtronics *Model Tester*, GIT

2022 – 2024 **Model-based software design for a 400 kW fuel cell system** – GLOBE Fuel Cell Systems GmbH (Stuttgart)

Period: 19 months

Content: Development of infrastructure and simulation architecture for hybrid fuel cell systems including all relevant interfaces; design of the simulation environment for a flexible and database-based exchange of components and I/O's; development of plant simulation models, model-based controller design and software implementation for components (high temperature cooling circuit for stack cooling, cathode circuit for oxygen reaction, coordinator for coordination of all software components, system Interface for interaction with HMI and system test bench); unit tests for software components; software-related support during commissioning of component test benches (close interaction and coordination with engineering and testing teams); parameter identification for plant simulation models; implementation of overall fuel cell system simulation model including all software components and plant (cooling circuit, cathode circuit, anode circuit, test bench, …); system tests and optimization of functionality

Tools: MATLAB/Simulink/Stateflow, ETAS, Jira, GIT

2020 – 2025 **Electronic Horse Saddle Pad** – designXtronics (internal project)

Period: 24 months

Content: Development and testing of an electronic horse saddle pad for continuous motion monitoring and analysis of saddle pressures, symmetry and horses back motion dependend on gaits:

Goal 1: Symmetry and motion

- Detection of asymmetrical load distribution
- Correlation between saddle load and gaits
- Dynamics of back muscles / suppleness of movement
- Riding tracks and corresponding GPS data (length, time, altitude, ...)

Goal 2: Saddle adjustment trend

- Analysis of saddle load trend over time (over all riding sessions)
- Statistic results: average and maximum pressure, symmetry, etc.
- Starting point for optimal adjustment via professional saddle fitter

For more information see www.maxpad.de.

Design & Development

- Saddle pad: design and realization of pad inlays containing FSR (force sensing resistor) sensors
- Electronic control unit: design of an electronic circuit diagram and a two-layer PCB (printed circuit board) for akquisition and filtering of pressure sensor data and motion data via intertial measurement unit (IMU) with quaternion theory; implementation of machine learning AI algorithms for gait detection
- Android App: programming of an comprehensive mobile app containing configuration of horses and saddles, real-time visualization of sensor data, trend analysis of pressures and symmetry including SQLite data base
- Test bench design and implementation for reproducable FSR sensor calibration

Tools: MATLAB/Simulink/Stateflow, Arduino Nano 33 BLE (ARM Cortex-M4F, 64 MHz), Arduino Due (ARM Cortex-M3, 84 MHz); Android Java, C and C++

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PROJECTS (Extraction)

2021 – 2022 **Functional Safety Software for Electronic Torque Manager (ETM®)** – GKN Driveline International GmbH

Period: 13 months

Content: Concept Development & Evaluation of model-based algorithms for Safety Torque Monitoring; Consulting and Support for Development of Functional Safety Software (ISO 26262, ASIL-B); Automotive SPICE®-conform development along Software Engineering Process Group (SWE); Ensuring quality maturity levels in corresponding development stages

Tools: MATLAB/Simulink/Stateflow, dSPACE TargetLink, PTC Integrity Lifecycle Manager

2019 – 2020 **Plant modeling & model-based control design** – Edscha Engineering GmbH (Remscheid)

Period: 6 months

Content: Derivation of physical equivalent model of an electric drive system containing components electric motor, transmission, coupling, load and non-linearities (e.g. friction, mechanical bound and kinematics); implementation of the complete drive system model, analysis and testing of dynamics; introduction of a cascaded control concept; model-based design of controllers and realization of a MATLAB® GUI for rapid control design and automized linear and non-linear analysis with corresponding plot figures for characteristics of system dynamics

Tools: MATLAB/Simulink/Stateflow, GIT

2019 – 2020 **Chassis Control Coordinator for autonomous driving** – (Salt & Pepper Technology GmbH & Co. KG)

Period: 15 months

Content: Consulting and coordination of tasks within the Salt & Pepper team; development of a MATLAB® user interface "Track Generator" for the interactive definition and kinematic analysis of reference trajectories for autonomous driving; consulting on development of a Simulink® functional architecture for series longitudinal controller; development of longitudinal control (library) functions for various requirements for position, velocity and acceleration controls; implementation of smooth switching mechanisms between several longitudinal controllers taking into account various situations (driving, stopping, standstill, starting, etc.); development of filter algorithms for reference values dependent on several constraints; development of Simulink® library blocks and a comprehensive MATLAB® GUI for definition and execution of automated unit tests

Tools: MATLAB/Simulink/Stateflow, GIT, Jira, Doors

2015 – 2018 **Rapid Control Prototyping test bench for model-based design of control algorithms for refrigerant circuits of heat pumps** – Vaillant (Remscheid)

Period: 24 months

Content: Commercial and technical head of overall test bench development: support with documentation of the specifications (requirements, components, interfaces, etc.), selection and research of actuators, sensors, power amplifiers and real-time system; development and implementation of powerful and generic software architecture and control software, extensive initial commissioning and Rapid Control Prototyping of modern complex algorithms for refrigerant circuit control

Tools: MATLAB/Simulink/Stateflow, dSPACE MicroLabBox and ControlDesk

2014 – 2015 **Model-based control of a Hardware-in-the-loop test bench for actuators of electric steering systems** – Ford (Cologne)

Period: 8 months

Content: Analysis of existing test bench control software, modeling of a steering system with actuators, integration of the steering system into a vehicle simulation model (ASM) for real-time implementation on the Hardware-in-the-loop (HIL) test bench; modeling of the HIL components (load motor, clutch, steering drive motor) and simulation of the overall test bench; concept development for an algorithm for active vibration damping (Kalman), simulation of the concept, implementation and commissioning on the test bench

Tools: MATLAB/Simulink/Stateflow, dSPACE DS1006

2013 – 2014 **Development of a test bench for analysis of efficiency of EPB spindles** – TRW (Koblenz)

Period: 24 months

Content: Commercial and technical project management for overall test bench development: support with documentation of the specification, dimensioning of components and CAD construction; implementation of a simulation study and derivation of requirements for selection and research of actuators, sensors, power amplifiers and real-time system; development of control approach and generic software architecture; construction, commissioning and approval of the test bench

Tools: CATIA, MATLAB/Simulink/Stateflow, dSPACE ControlDesk und DS1006

2012 – 2013 **Development of a Hardware-in-the-Loop test bench for actuators of electric steering systems** – Gigatronik (Cologne)

Period: 8 months

Content: Commercial and technical project management for the overall test bench development: support with documentation of the specifications, dimensioning of components and CAD construction; selection and research of actuators, sensors, power amplifiers and real-time system; model-based control design (modeling of steering system, extensive linear analysis and functional testing)

Tools: MATLAB/Simulink/Stateflow, dSPACE ControlDesk und DS1006

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PROJECTS (extract)

2011 – 2012 **Model-based control of a magneto-rheological absorber to limit the spinal force of vehicle occupants** – Gigatronik (Stuttgart)/Inventus (Austria)

Period: 6 months

Content: Modeling and implementation of a magneto-rheological absorber system as well as linear and non-linear analysis of system dynamics; design and implementation of a controller with a non-linear observer (Kalman) to estimate the spinal force; offline simulation of the closed control loop for analysis of the absorber and derivation of the requirements for absorber, control unit and interfaces; real-time implementation and application

Tools: MATLAB/Simulink/ Stateflow, GIGABOX pro and dSPACE MicroAutoBox

2011 **Control software for a keyless entry and start system** – Delphi (Wuppertal)

Period: 9 months

Content: Specification of an event-based keyless system functionality with regard to modularity, AUTOSAR conformity and production C code generation; specification with customer and implementation of all keyless functions; development of Simulink environment for offline simulation and analysis of the overall algorithm; extension of the keyless development environment by a complex MATLAB user interface for visualization of locking functions and antenna search rooms/areas for reproducible function tests within offline simulation

Tools: MATLAB/Simulink/Stateflow

2010 **Development and implementation of control algorithms for brushless DC motors** – Pierburg (Neuss)

Period: 4 months

Content: Physical modeling of a rotating drive unit, model-based design of a cascade controller (current, speed, position); development of an algorithm for commutation and field-oriented current control of a motor prototype

Tools: MATLAB/Simulink

2009 – 2010 **Real-time Blockset for the rapid prototyping system "GIGABOX pro"** – Gigatronik (Cologne)

Period: 8 months

Content: Specification of Simulink interface blocks and configuration for GIGABOX pro interfaces (AD-Converter/DA-Converter, digital I/O, PWM output, CAN, RS232, etc.); realization of a block library with a powerful generic API functionality; testing and commissioning of all interfaces under real-time conditions; specification and implementation of extensive online help for the **Real-Time Blockset**

Tools: MATLAB/Simulink/Real-Time Workshop

2008 **Model-based control and diagnosis for active toe angle and camber angle adjustment** – BMW (Munich)

Period: 4 months

Content: Supervision and coordination of the prototypical development of a real-time capable Simulink algorithm for the implementation of an active toe angle and camber angle adjustment on the rear axle of a vehicle; analysis of potentials for vehicle dynamics control; development of a prototypical model-based diagnosis

Tools: MATLAB/Simulink/Stateflow, dSPACE MicroAutoBox

2006 – 2007 **Observer-based current control for a magnetic actuator** – Siemens VDO (Schwalbach)

Period: 16 months

Content: Physical modeling of a magnetic actuator; development of a non-linear parameter observer; design and implementation of a model-based classic current control based on observer output

Tools: MATLAB/Simulink/Stateflow, dSPACE ControlDesk and DS1005

2004 – 2005 **Environment for the development and implementation of driver assistance functions using the example of a model car** – Gigatronik (Stuttgart)

Period: 10 months

Content: Thesis supervision: setup of a model car (1:12), which is located on a flat track unit and is equipped with sensors for distance detection, and the associated hardware and software; design and implementation of a gain-scheduled H-Infinity controller for position control of the model car

Tools: MATLAB/Simulink/Stateflow, dSPACE ControlDesk and DS1005

2004 **Optimal state-space controller for electro-mechanical power steering** – BMW (Munich)

Period: 8 months

Content: Physical modeling of the steering system; development of an environment for the rapid automated design of a Linear Quadratic Gauss (LQG & Kalman) controller for zero torque control of an electro-mechanical power steering system; real-time implementation and coordination of the controller in the test vehicle

Tools: MATLAB/Simulink, dSPACE ControlDesk and MicroAutoBox

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PROJECTS (extract)

2004 **Modeling of a vehicle on a roller test bench for a diagnostic tester** – Daimler (Sindelfingen)

Period: 6 months

Content: Physical modeling of a vehicle drive train including tires on a controlled roller test bench; generation of the model C code and implementation on a real-time capable PC as a simulation and test environment for a diagnostic tester

Tools: MATLAB/Simulink/Stateflow, dSPACE TargetLink and dSPACE ControlDesk and DS1005

2003 – 2004 **SIL-Simulation of a cruise control algorithm** – Daimler (Untertürkheim)

Period: 3 months

Content: Programming of a powerful MATLAB graphical user interface for the interactive and reproducible Software-in-the-Loop (SIL) test of a cruise control algorithm for commercial vehicles in offline simulation with logging and analysis functionalities

Tools: MATLAB/Simulink

2003 - 2004 **Modeling and simulation of a two-track vehicle model** – Gigatronik (Stuttgart)

Period: 18 months

Content: Development, implementation and real-time test of a generic two-track vehicle model for use in vehicle dynamics applications in offline and online (real-time) simulation

Tools: MATLAB/Simulink/Stateflow, dSPACE DS1005 and AutoBox

2003 - 2004 **Active vehicle fixing control and driving resistance simulation** – Daimler (Sindelfingen)

Period: 12 months

Content: Model-based development, implementation and commissioning of a cascade control for a position-controlled fixing functionality via active air springs to fix a vehicle on a driving dynamics test bench; development, implementation and commissioning of an algorithm for simulating driving resistance for the driving dynamics test bench

Tools: MATLAB/Simulink/Stateflow, dSPACE-ControlDesk and DS1005

2003 **Drive train model with automatic transmission and Tiptronic** – Daimler (Sindelfingen)

Period: 3 months

Content: Physical modeling of a vehicle drive train with automatic transmission and tiptronic functionality for an FMU (Functional Mockup Unit); generation and implementation of the C code on a real-time capable PC

Tools: MATLAB/Simulink/Stateflow, dSPACE TargetLink

2002 – 2003 **Model-based control algorithm for reversible belt retractors** – TRW (Alfdorf)

Period: 6 months

Content: Development of a model-based triggering algorithm for a reversible belt retractor; generation of the production code and commissioning as well as coordination of the prototype in the test vehicle

Tools: MATLAB/Simulink, dSPACE TargetLink, GT-uniECU

2002– 2003 **Control of an exhaust gas recirculation valve** – Gigatronik (Stuttgart)

Period: 6 months

Content: Physical modeling of an exhaust gas recirculation valve as well as development, implementation and commissioning of various control approaches (PI, PID, LQG, H-inf, ...) for training purposes

Tools: MATLAB/Simulink, dSPACE ControlDesk, DS1005 and Autobox

2001 – 2002 **Development of electrical steering systems** – Mercedes-Benz Lenkungen (Esslingen)

Period: 14 months

Content: Requirements management for electrical steering systems; physical modeling of various electrical steering systems (EPAS, superimposed steering); specification of requirements for mechanical engineers; model-based development of various modern control approaches (LOQ); production code generation for fixed-point arithmetic; implementation on prototyping hardware and validation in the test vehicle and in driving tests;
development of an environment for automatic identification of linear and non-linear electric motor parameters

Tools: MATLAB/Simulink, dSPACE ControlDesk and Autobox

1999 – 2001 **Development of scaling tools for fixed-point production code generation with TargetLink** – dSPACE GmbH (Paderborn)

Period: 20 months

Content: Specification of methods and tools for scaling variables of dynamic (state-space) systems in fixed-point arithmetic for automatic production code generation; programming of API functions and user interfaces for scaling, analysis and visualization of time responses of dynamic systems

Tools: MATLAB/Simulink, dSPACE TargetLink