

## The Team:

An interdisciplinary and international team of more than 60 highly motivated students in total and about 10 students especially for the Mi5-Dartboard were forming the project Mi5. They originated from a variety of fields and nations (China, Egypt, Germany, Italy, Poland, Spain, and Tunisia) and built up the entire project in cooperation with partners from industry, research and education.

Mi5 stands for „Mechatronic Ideal Engineering“, which fulfills the following 5 i's: innovative, interdisciplinary, international, incremental and iterative.



## Project Goals:

- Prototype Development: Implementation of a modular mechatronic highspeed tracking system as a vivid demonstration at fairs
- Practically Relevant Training: Interdisciplinary project work in cooperation with industrial partners
- Tool-Based Systems Engineering: Application of agile mechatronic development methods, such as Scrum, and tool-based engineering.
- Experimental Industry 4.0: Illustration of implementation of human-machine interaction based on Industry 4.0 focused technology.



The Mi5-Dartboard is a modular mechatronic system which is not only able to detect a thrown dart, but can also analyze the flight path and therefore predict the area of its impact in real-time. To validate these predictions, the so called bullseye of a highly dynamic dartboard is placed at the expected position, within a time span of 120 milliseconds at the most.

As only the bullseye is meant to be hit, the remaining elements of the dartboard were replaced with a virtual, projected model which appears on the screen right behind the target and of course it moves accordingly. Therefore it represents an impressive synchronous interaction between „cyber“ parts such as the mathematical analytics, and the „physical“ aspects, such as mechanical elements.

## About ITQ GmbH

ITQ GmbH consults and supports during all phases of software development, allowing for special mechatronic problems in mechanical engineering. The core competencies, besides software engineering (comprising analysis, design, implementation, and test), are process improvement, project management, and crisis management as well as consulting and coaching. One particular focus of the company is suitable and forward-looking training concepts. For that reason, the company fosters young academics in practice-oriented assignments such as the Mi5 project.

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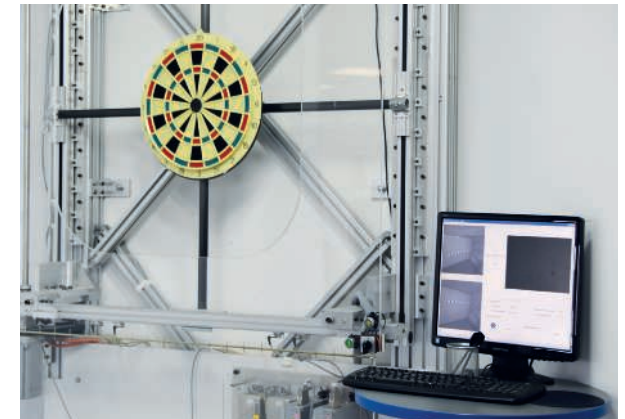
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competence in mechatronics  
software and systems engineering

## International Student Project

### Mi5-Dartboard



#### Universities:



## The Project:

- Development of a modular system as a demonstrator for mechatronic engineering
- High speed image analysis under real-time conditions
- Demonstration of ideal engineering and development methodology using practical examples
- Interdisciplinary development and project management in an international student team

## Module: Sensors

- Detects the thrown dart
- Traces the dart at 100 fps
- Analyses the flight path in real-time
- **Silicon Software/ MvTec**

## Module: HMI - Input

- Controlling the system with an intuitive, wearable interface  
**Android Smartwatch**

## OPC UA and web services

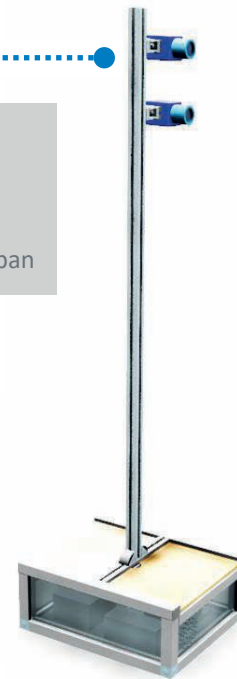
- Service-oriented architecture (SoA)
- Connection of the modules with a combination of classical interfaces like CanOpen and modern approaches like OPC UA
- Future-oriented architecture for expanding the functionality

## Module: HMI - Feedback

- OPC-UA-client-based live visualization of system parameters
- Expandable functionality
- Easy calibration for lining up real elements with virtual animations
- Symbol based feedback for universal, language independent comprehension

## Smartwatch functions

- Login
- Start the game
- Show the remaining timespan



## Modularity & Communication

- CanOpen technology for an easy exchange of modules which depend on real-time communication
- OPC-UA server-client system for a standardized access to system parameters
- Web services for implementation of wearable devices

## Development methodology

- Integrated mechatronic development
- Intersection of classic methods and agile methods like Scrum
- System specification and information networking
- Systems Engineering: Functional development



## Module: Actuators

- Places the bullseye on the calculated flight path with up to  $100 \text{ m/s}^2$  at  $8 \text{ m/s}$
- Moves within a range of up to 340 mm from the center in each direction
- **B&R**