aedesign.

Mechanical Design

Computer-Aided Engineering

Embedded Systems and Robotics

Product Visualisation

Conceptual Design

Mechanism Design

Technical Illustrations

Detail Design

Fluid Power System Design

Welcome to AEDesign, an engineering company focused on high-end product development and engineering consultancy. We specialise in engineering and analytical services for the industrial machinery and automotive sectors as well as product development in robotics and renewable energies. Our mission is to provide our clients with a professional and high quality service that leverages on nearly 15 years' of industry experience.

We assist our clients from concept through validation to finished prototypes and/or finished products. Our professional in-house team brings your ideas to fruition, be it an integral part of a sub-assembly or an entire system. Our engineering team has the experience and background to bring a level of expertise adaptable to a changing manufacturing environment without compromising the quality of our services.

I founded AEDesign in 2002 with a focus on providing engineering services to the automotive industry. Since those early days, we have expanded our horizons to include renewable energy, robotics and industrial machinery. In a further commitment to our European clients we established a permanent presence in Germany in 2010. My continuing dedication to excellence is instilled in our entire team. Engineering challenges excite us and encourage us to constantly work to surpass the expectations of our clients.

Why choose AEDesign for your next projects? Our level of expertise is unmatched. Our dedication to your project is unwavering. Our efficient engineering base allows us to bring true value to your projects.

Allow us the opportunity to discuss your engineering challenges.

Zaafir Waheed
CEO
AEDesign

aedesign.

Portfolio Overview

From its initial focus on the automotive sector, AEDesign also expanded into creating value enhanced engineering solutions for the industrial sector.

Our range of services covers Mechanical Design, Embedded Systems and Robotics, Computer-Aided Engineering and Product Visualisation. AEDesign offers several ways of cooperation with our clients, tailored to each one's specific requirements.
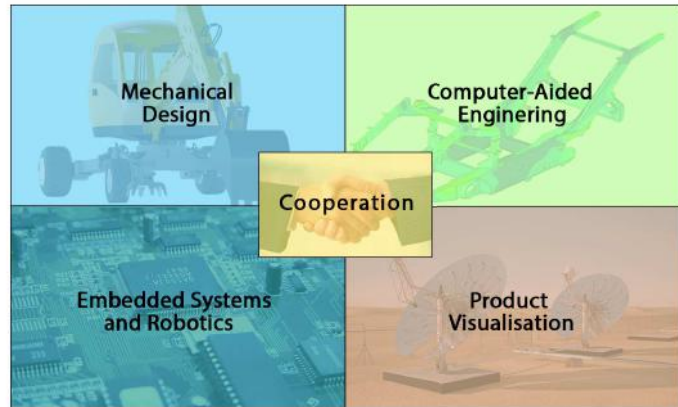
Mechanical Design

- **Conceptual Design**
- **Detail Design**
- **Mechanism Design**
- **Fluid Power System Design**
- **3D Model Construction/Database Management**
- **Technical Illustrations**

Conceptual Design

The extensive engineering disciplines which we have in-house allow us to put together innovative and well thought out concepts, from small systems to large complex machinery. We can manage a complete project from conceptual design right through to the release of manufacturing drawings and service support material.

The Walking Excavator – **A showcase of our engineering skills and expertise**

This project started as an in-house design competition to create a full machine which would allow us to demonstrate the complete range of our skills. The walking excavator was chosen due to the design complexity and multi-disciplinary engineering challenges that it posed.

Features of 'The Walking Excavator':

- ■ Robust and flexible chassis with four independently operating legs, each with multiple degrees of freedom for all-terrain activities
- ■ Front legs feature support wheels and stabilising outriggers whereas rear legs provide propulsion via driven wheels
- ■ Operator cabin is designed to provide unobstructed visibility, comfort and full safety to the driver according to highest international standards:
  - ISO 12117-2:2008 for ROPS (Roll Over Protective Structure)
  - ISO 3449 for FOPS (Falling Object Protective Structure)
- ■ 'The Walking Excavator' is extremely versatile, being able to operate on very challenging terrain and does not cause unnecessary environmental degradation because of its relatively low ground pressure

Detail Design

AEDesign provides efficient and comprehensive services when it comes to detailing and customization of existing designs. Whether it's a machine that needs to be modified and enhanced, or a concept that has to be realised into a production ready design, we take up the challenge and master it. Our engineers work in close collaboration with the client's in-house teams to understand specific requirements and functions. Once we have collected all necessary information, we apply our engineering expertise to not only implement predefined goals but also to propose our own solutions where we deem appropriate.

3D Model Construction and Database Management

3D CAD programs have revolutionised the way how engineering projects are executed in this day and age. Our design team uses state-of-the-art software systems to transform ideas and concepts into 3D representations of the final product including all its functionalities and features.

AEDesign has comprehensive experience in transferring 2D CAD data into modern 3D systems, our engineering knowledge allows us to thoroughly assess the data and remove intrinsic design issues which are generally found in 2D CAD design before delivering the results in 3D CAD format.

Apart from working on the 3D level, our team is also well-experienced in the preparation of manufacturing drawings for existing designs that can be used directly for manufacturing purposes.

With increasing complexity of mechanical designs, CAD Data Management Systems have become indispensable in the design process. AEDesign offers its services in this field and provides qualified support in creating, managing and optimizing CAD database structures in order to achieve highest efficiency in utilization for the customer.
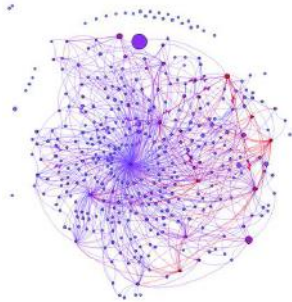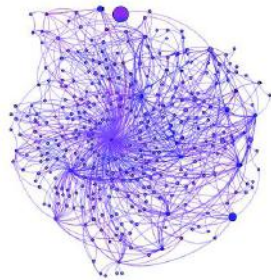
Technical Illustrations

Technical illustrations and manuals have great significance in conveying product related information for various purposes such as product usage guidance, maintenance and repair instructions or spare parts lists. They are essential parts of the product documentation and therefore necessary when complex machines or tools are distributed to customers worldwide. AEDesign generates engineering drawings of all complexity levels as well as complete manuals including exploded and detail views. These manuals can be linked to a database allowing automatic updates whenever the design is changed.

Our engineers have extensive experience in making such illustrations for a wide range of applications.
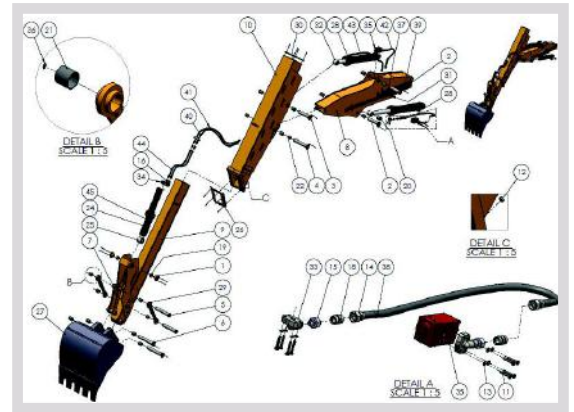
Typical visualization of a CAD interlinked system: red nodes and lines show defective parts (either duplicates or corrupted SysID), nodes without relations are parts/assemblies which do not have any parent elements and therefore represent redundant items of the database

Data Cleansing

AEDesign is experienced in maintaining complex CAD databases used by large engineering teams. We are able to rationalise and clean the database to ensure that it remains error free without including unnecessary duplications.

These activities not only become essential in order to facilitate migration to new PDM systems, but also help in reducing inventory and saving considerable costs.

Our large and flexible team allows us to execute such resource intensive projects in short time periods while maintaining a very competitive cost level.

Visualization of the 'cleansed' system: redundant parts and assemblies were deleted, defective items are fixed or replaced

Mechanism Design

Mechanisms are usually designed to transform 'mechanical input' consisting of forces and movement into a desired mechanical output which enables the system to execute the required functionality.

AEDesign provides extensive inter-disciplinary technical knowledge and experience to support our clients in the development of mechanisms with minimized internal loads and a cost-efficient designs, aiming to reduce material and manufacturing costs as well as production and assembly time.
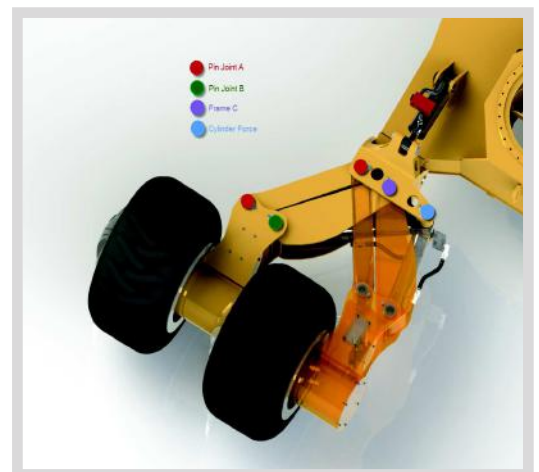
Fluid Power System Design

Virtually all modern static and mobile machinery use fluid power systems because of the flexibility in design and load adjustment that such systems allow. AEDesign designs and analyses fluid power systems for all types of machines or vehicles while taking into account specific requirements related to the field of application. Appropriate use of hydraulic components, like flow restrictors, flow orifices and pressure reducing valves, enables systems designed by us to function safely and reliably.
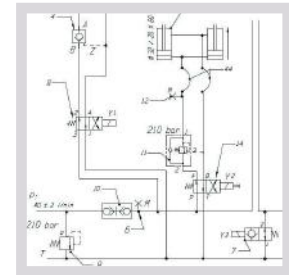
We evaluate hydraulic systems by using multi-body models, integrated with hydraulic circuits. Real time simulations of mechanisms and circuits help us in investigating the dynamics of hydraulic system components and therefore to optimize the complete system setup which reduces cost and complexity of the solution.
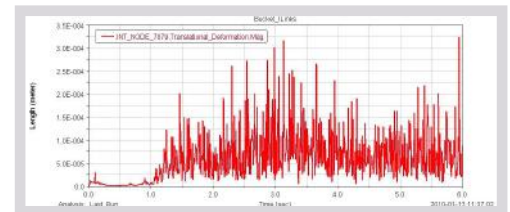
Computer-Aided Engineering (CAE)

In today's world, Finite Element based methods allow designs to be virtually tested and validated before prototyping, saving significant amounts of time and money. It is possible to determine the behavior of the complete system as well as for separate components by a large variety of analysis techniques ranging from basic integrity calculations to more complex simulations predicting the estimated life of a structure.

AEDesign has solid experience and expertise in carrying out Finite Element Analyses for designs of all complexity levels. From preprocessing activities (meshing, contact definition, boundary conditions, etc.) right through to postprocessing and design optimisation, we help to ensure that your designs will function as you intended them to.

With our team of experienced simulation experts we are able to offer the following types of analyses:

- Static Analysis
- Dynamic Analysis
- Life Estimations (fatigue analysis)
- Non-Linear Analysis
- Computational Fluid Dynamics

Preprocessing

The first steps in any simulation work are essential in ensuring that the results of the simulation are reliable. These steps include, but are not limited to, mid surface generation, mesh generation and modeling of connections. For clients who require FE-models for simulations carried out by their own in-house team, we offer meshing for crash simulations and stress analyses as well as for composite parts.
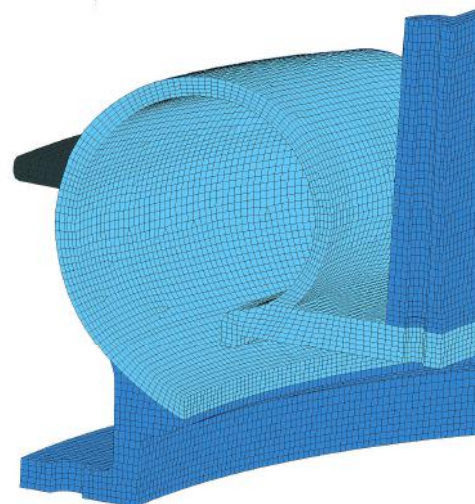
Static Analysis

AEDesign prepares and executes linear and non-linear simulations as per the client's individual requirements. Once the initial simulation results are compiled, we also offer suggestions for design optimisations and improvements in the form of a detailed report, e.g. to achieve a reduction of stress in critical parts or to minimize the mass of certain components. Optimisations like these target cost savings in material and production and also help to improve the understanding of the product's detailed functional response.
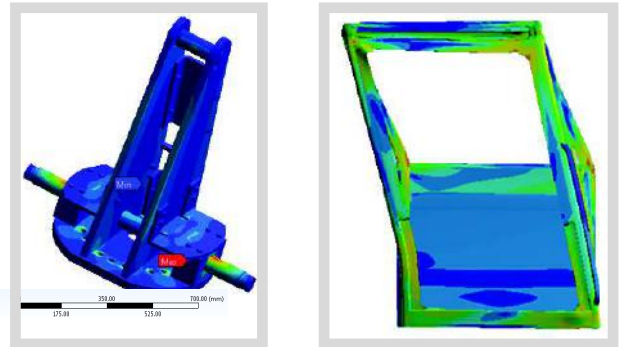
Vibration Analysis

The range of analyses performed by our engineers includes modal analysis, sine sweep analysis and random vibration analysis (PSD spectrum). These different simulations allow us to determine natural frequencies, Eigen modes and maximum deflections of the system. Vibrations not only reduce the life time of a structure but can also lead to catastrophic failures in the worst case, especially in combination with an excitation close to the resonance frequency. A detailed knowledge about the dynamic behaviour of the product is therefore absolutely necessary for most cases.
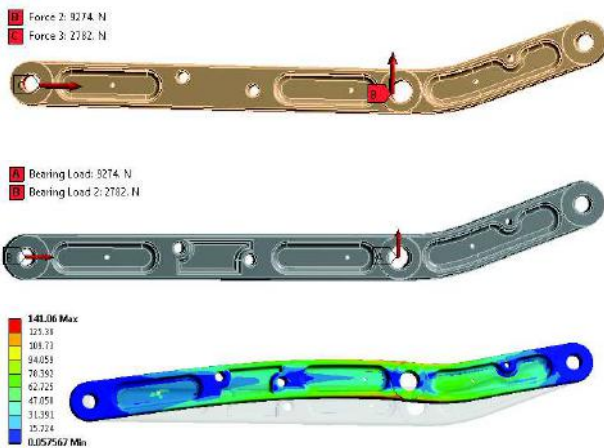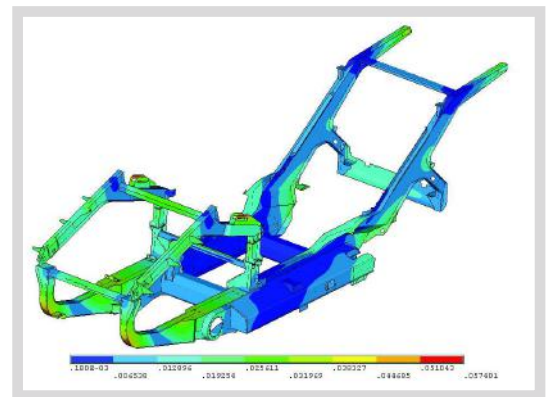

Fatigue Analysis

In order to accurately estimate the safe operational life time of a structure exposed to cyclic loading, fatigue calculations are essential. Fatigue failure is manifested by cracks forming in the stressed areas of the design usually after a large number of load cycles (high cycle fatigue). A structural analysis is carried out in the first step to determine stresses at the relevant location which are then evaluated in the next step by using scientific guidelines and concepts which enables the specialist to predict the life time of the part at the specific position.

Computational Fluid Dynamics

Our simulation team has many years' worth of experience in carrying out CFD analyses for applications ranging from large structures to analysing the effects of fluid flows in small parts. Using input from CFD simulations we are also able to combine these results with structural analyses in order to study mechanical strains due to environmental factors.
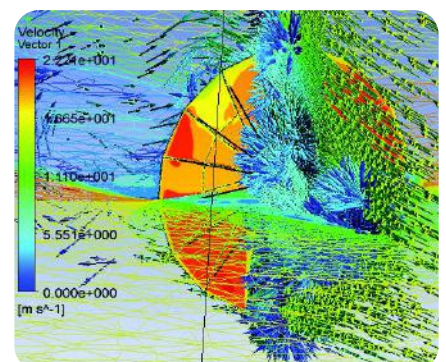
Embedded Systems and Robotics

State-of-the-art, complex machinery quite often depends on the successful integration of mechanical and electrical systems in order to fulfill intended requirements. Embedded systems, as the central part of every control unit, represent a special-purpose system dedicated to perform a number of predefined tasks. Combined with sensors and customised actuation systems, embedded systems control core functionalities in many fields of application which were previously defined as being purely mechanical, such as transportation, production lines and tooling machines.

AEDesign bridged the mechanical and electronics disciplines with the addition of mechatronic design. This approach has served well, not only in successful development of the company's own products like the AVCASS or the Solar Invictus but also for client projects. AEDesign's engineers specialised in embedded systems and robotics, have a solid track record in handling developmental challenges and successful delivery of projects.

Embedded System Development

AEDesign supports all steps in embedded system development, starting with a detailed study of all existing requirements and an assessment regarding their effects on the systems' configuration as well as potential interactions between the processes.

After finalising the specification of the overall hardware and software design, detailed hardware development starts with electronic circuit and PCB design using advanced industry software tools.

In the field of software development, our engineers are proficient in numerous programming languages and adaptable to project requirements. All code is written in accordance with international standards and best practices, and is then put through rigorous performance testing procedures at all system levels.
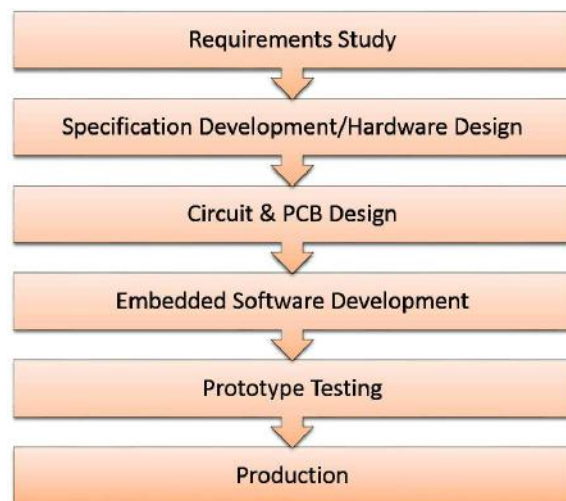
Expertise in Hardware Development

- Circuit design for various applications, e.g. integrated control systems for autonomous robotic systems
- Protection circuitry: Over-voltage, surge and short-circuit protection
- Electromagnetic compatibility: isolation of specific components for noise reduction
- Multi-layer PCB design
- Ruggedized PCB design for harsh environments and high EMI level
- Thermal management in PCB

Expertise in Software Development

- Development and implementation of control strategies for complex applications
- Design of Graphical User Interfaces (GUI)
- Android based app development
- Code quality control: Adherence of coding standards (such as Google C++ Style Guide or Arduino-based coding for micro-controller), periodic refactoring
- Software testing: Unit testing, integration testing, component interface testing, system testing

Robotics

AEDesign's strong abilities and experiences in both mechanical and electrical engineering create the basis to execute projects that include development, manufacturing and testing of complex robotic systems for industrial applications, either as a customer defined project or in order to support the company's own product development activities. Two of the in-house developments from AEDesign demonstrate our capabilities to support our customers in the field of robotics.

AVCASS - Autonomous Vehicle for the Certification of Active Safety Systems

In the area of crash safety and collision safety, increasing focus is being made on collision mitigation and active safety to reduce the occurrence of accidents, as opposed to simply relying on passive safety and reducing the impact of crashes.

AEDesign has developed a testing platform that simulates the motion of various types of targets to test active safety systems. This platform is called the AVCASS (Autonomous Vehicle for the Certification of Active Safety Systems). The AVCASS test platform is an ultra-low profile, overrun safe test tool able to provide full mobility to a range of test targets. An innovative drivetrain allows it to provide realistic movement to a variety of test targets ranging from pedestrians to balloon cars.
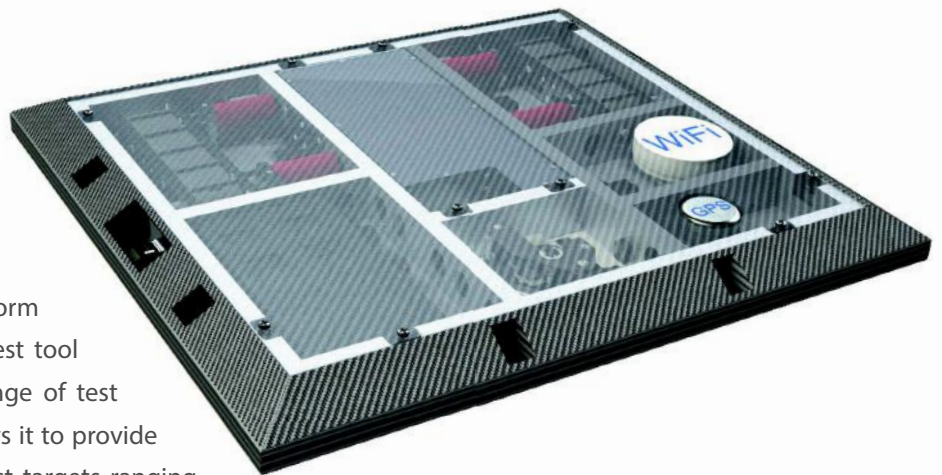
As the 'brain' of the AVCASS, engineers from AEDesign have developed an integrated control unit which is processing incoming information from the sensor system such as the GNSS (Global Navigation Satellite System) and IMU (Inertial Measurement Unit) enabling the AVCASS to follow predefined pathways autonomously. Alternatively, the operator can also directly control the AVCASS in manual operation mode using the operator control unit and wireless communication module of the AVCASS.

► **Low profile testing platform for automotive active safety systems**

► **Withstands multiple over-runs at realistic test speeds, vehicles can even brake on top of it**

► **High level of navigation precision with comprehensive fail-safe concept**

► **Fully autonomous control system follows user-defined waypoints during test procedure**

AVCASS Fail-Safe Concept

The platform's control unit software detects several forms of deviations or errors which cause an immediate action in order to ensure a safe and stable status of the vehicle in all situations.

Communication loss: In case the communication module loses contact with the operator, AVCASS will automatically stop and wait for a reconnection. An automatic 'home-coming' function can be used to check for potential hardware failures at the base station. The same system behavior applies if the signal quality from the GNSS drops significantly so that an appropriate navigation accuracy is not achievable anymore.

Overrun/Impact: AVCASS detects any overrun or excessive impact and stops the motors from further driving the platform. After a predefined delay, it returns 'home' in order to enable the test crew to check the vehicle.

Path following error: If the control unit detects a deviation from the predefined path which is exceeding a tolerance margin, AVCASS aborts the mission and returns to the home base for following checks. The operator can also predefine safety areas where the system is not allowed to operate in order to avoid any interferences with equipment or personnel.

Sun Tracking System for the Solar Invictus

The Solar Invictus is a Concentrated Solar Power (CSP) based steam generation system following the parabolic dish design. The principle is to collect and focus incoming sunlight into the cavity of a thermal receiver unit where energy is utilised to evaporate feed water and thereby to supply steam of a predefined quality to the intended application (e.g. Thermal Enhanced Oil Recovery, Process Industry, Thermal Desalination, etc.).

Ultra-precise tracking of the sun is absolutely necessary to achieve the industry-leading performance of a net sun-to-steam-efficiency of 88% at real-life conditions. The control unit of the sundish adjusts elevation and azimuth angles of the concentrator automatically in order to utilize as much direct insolation as possible for the steam generation process. Dual-axis tracking offers significant advantages in terms of energy efficiency compared to a single-axis system but also requires a more sophisticated control strategy as well as additional actuators.
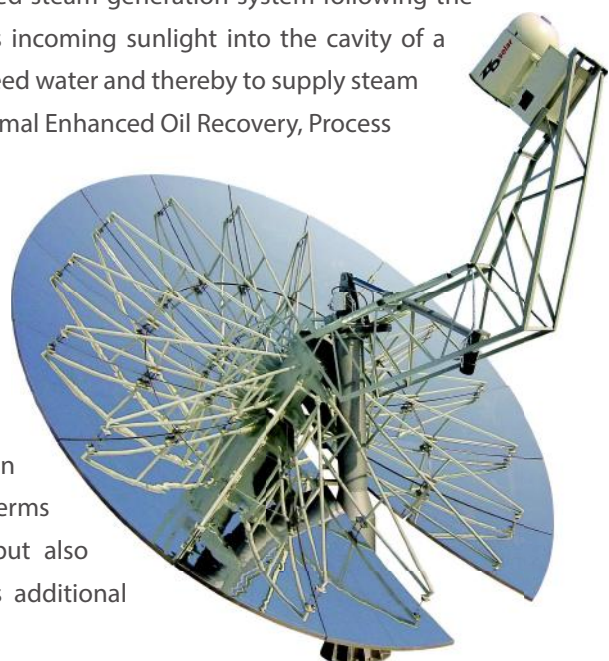
Automatic Cleaning Functionality - Full Desert Suitability for the Solar Invictus

Apart from the exact alignment of the Solar Invictus to the position of the sun, high-reflective mirrors which are part of the concentrator need to be cleaned regularly to avoid optical performance losses. Areas with an attractive insolation level are often found in remote desert locations with high concentrations of dust in the air and also high effort that has to be taken if the equipment needs to be cleaned manually.

In order to overcome this challenge, the Invictus design includes a fully automatic cleaning system based on a robotic arm removing any soiling from the mirrors on a scheduled and event-driven basis. The fully autonomous control algorithm detects the need for cleaning and controls the process itself without requiring any manual or external input.

Together with the robust design of the concentrator and receiver unit, the automated cleaning system enables the Invictus to excel even in harsh desert environments without any compromise on performance, availability and cost.

► **In-house developed dual-axis tracking system for optimal alignment of the concentrator unit**

► **Fully automated cleaning functionality: diagnosis system and 3-DOF robotic arm equipped with proximity & pressure sensors as well as limit switches to maintain full optical efficiency**

► **Actuator and control system specifically designed to withstand harsh desert environments and to achieve ultra-precise tracking results**
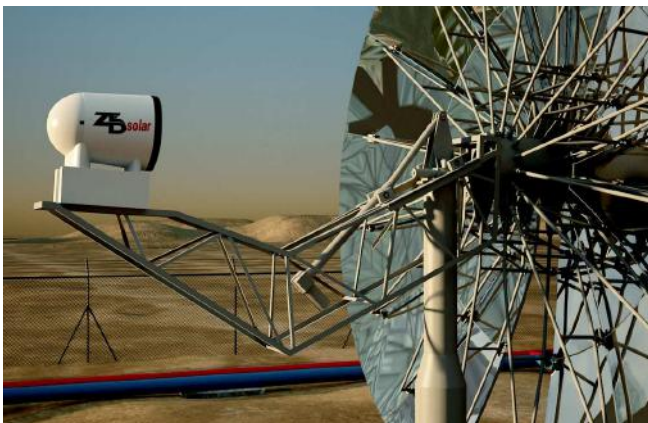
Product Visualisation

Today, mechanical engineering and development processes widely use 3D CAD models for defining the technical design of a product. A three dimensional representation helps engineers to better understand all implications of their design, e.g. related to space requirements or interactions with other components of the system. Apart from the pure technical development process, CAD models are also exceptionally useful to interact with potential customers and to present the concept before prototyping. In order to support our clients in this field, AEDesign offers its comprehensive capabilities in Product Visualisation:

Present the Product - Explain the Product - Convey Philosophy

Product presentation basically means 'bring the design to life': CAD models in their original form are meant to include and convey technical information – AEDesign uses the CAD data to create realistic and attractive images or animations which can be used to show potential clients what the final product will look like. Our extensive experience in mechanical engineering enables us to work with in-depth knowledge about the

technical background and to support sales, marketing and business development activities of our clients much more effectively than companies which are simply offering visualisation services.

Explain the product – or in other words: showcase the whole variety of applications and product features, demonstrate the full portfolio of functionalities, let the customer know what is unique and innovative about the new product. Again, with AEDesign's technical background knowledge we are able to tailor the content to the individual requirements of our clients and help to achieve the best representation of their ideas and visions.

Convey philosophy - Visualisations can be a powerful way to highlight product features and performance. For example, a harsh environment in which the product is shown, demonstrates reliability and robustness, a classic and luxury setup underlines elegance and dedication to design. AEDesign understands how to incorporate elements of the client's philosophy into the visualisation, to convey what the product stands for and what specific values the client wants to have linked with his product.

High-quality renderings and animations

- Photorealistic 3D modelling and texturing
- Real-world light settings and effects
- Detailed visualisation of design features
- Incorporation of realistic environment setups

- Motion graphics/corporate presentation
- Precise animation of technical functionalities
- Post production (subtitles, speech, music)
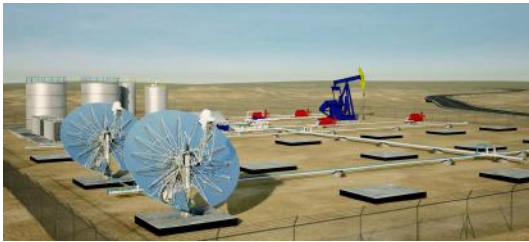
Cooperation

On-site/Off-site opportunity

Depending on the client's individual demands, AEDesign offers its complete portfolio either as remote services (off-site) from the company's offices in Lahore or directly at the client's facilities (on-site). In the 'off-site' mode, all work is carried out from Lahore using secure data connections to exchange required information. On-site placements are the preferred solution for projects where intensive interaction between specialists from the client and AEDesign is required. The on-site option also provides additional potential to the client in terms of flexible capacity shifting within a project.

Low turn-over rate at AEDesign

Long-term business relations and projects benefit from consistency in the overall team composition since engineers acquire know-how and experiences during the execution of projects. Our low turn rates mean that in most cases it is possible to keep the same team for subsequent projects and thereby gain efficiency and speed.
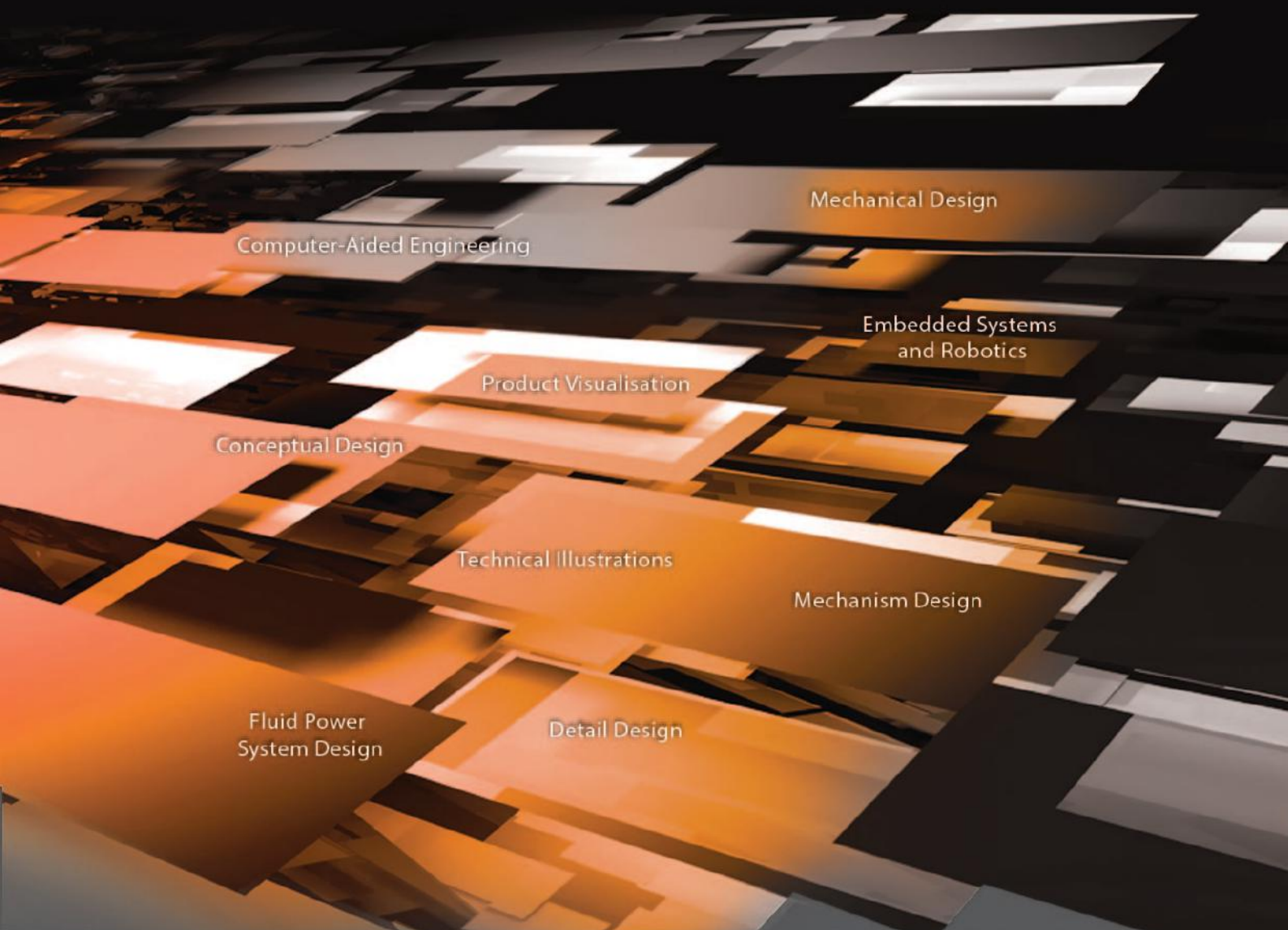
Data exchange and security

Secure data exchange is a vital part in our efforts to establish an efficient and secure way of communication with our clients. Therefore, confidential information are handled with special care and will be exchanged only via suitable procedures like password-protected FTP server exchange or VPN tunnel connected to the client's secure servers. All projects within AEDesign are handled on a 'need-to-know' basis which implies that only engineers who are directly involved in a certain project have access to the related data. Non-Disclosure Agreements (NDA), signed between our clients and AEDesign as well as between AEDesign and our employees, provide additional security for the handling of confidential data. Our servers are equipped with state-of-the-art firewall protection systems and all data on the servers are regularly backed up to completely separate disaster recovery sites in order to avoid data loss.